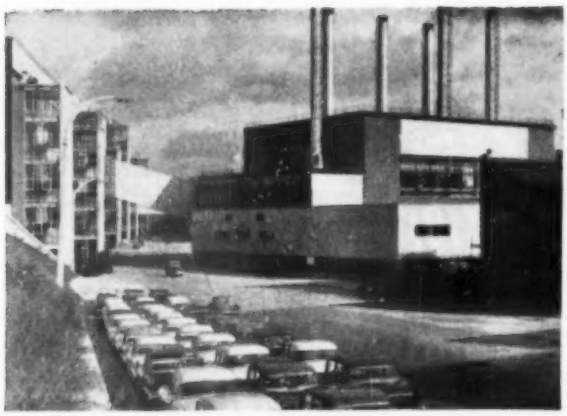
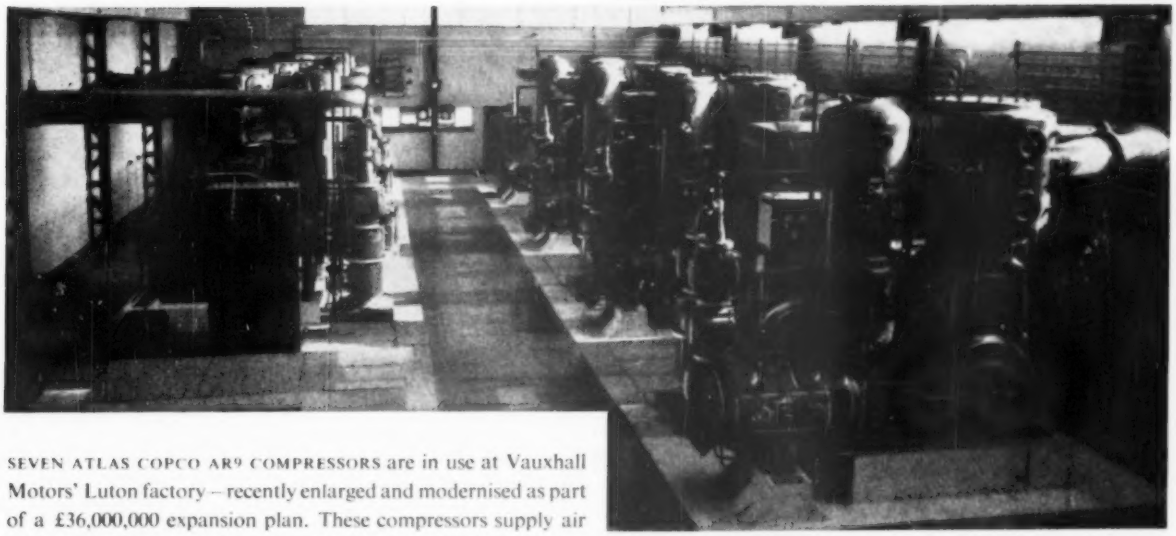
AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 50 No. 1 JANUARY 1960 PRICE: 3s. 6d.

Compressed Air at work in Vauxhall's Luton extension





SEVEN ATLAS COPCO AR9 COMPRESSORS are in use at Vauxhall Motors' Luton factory – recently enlarged and modernised as part of a £36,000,000 expansion plan. These compressors supply air to the body fabrication shops, press shops and other departments, providing power for clutch movements; resetting presses; mechanical handling; loading; welding; and mixing and spraying paint. In addition air is supplied for a number of pneumatic tools such as wrenches, grinders, drills and hoists.

ECONOMIC INSTALLATION

The AR9 compressors were installed at a cost below that estimated for other compressors of the same capacity. The reason being that the AR9 occupies 25% less floor space than is normally required —with consequent economies in compressor house costs.

HIGH OUTPUT

The Atlas Copco AR9 combines thorough reliability of performance with unusually high output per horsepower consumed. The installation at Vauxhall's has a total output of 22,540 c.f.m.

A COMPLETE RANGE OF COMPRESSED AIR EQUIPMENT

Atlas Copco manufactures portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. Sold and serviced by companies or agents in ninety countries throughout the world.

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local company or agent or write to Atlas Copco AB, Stockholm 1, Sweden or Atlas Copco, (Great Britain) Limited, Maylands Avenue, Hemel Hempstead, Herts.

C.16

when the going is tough . . . .

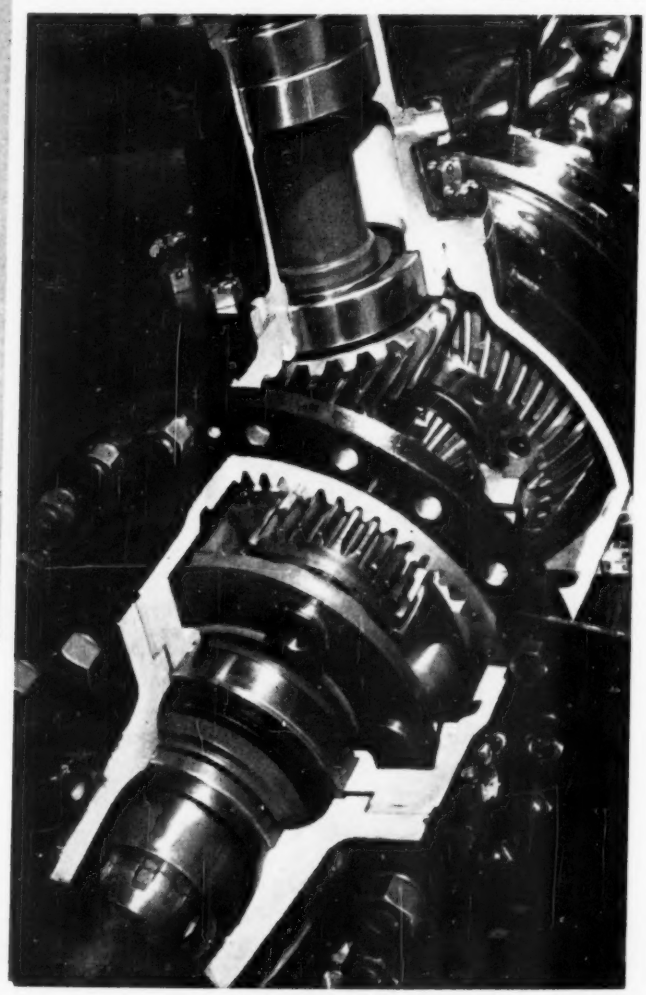
DROP FORGINGS

by

FIRTH-DERIHON

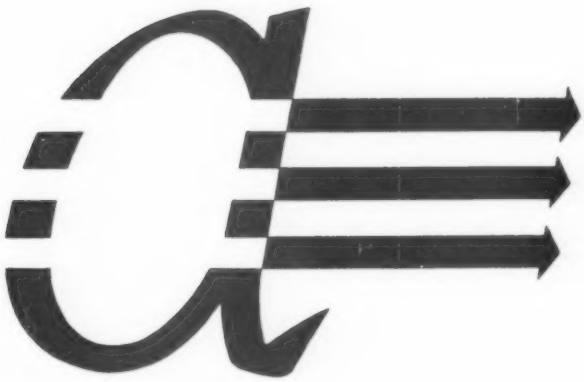
SHEFFIELD & DARLEY DALE

A 16mm. Colour Film with sound commentary, entitled "Drop Forgings in Alloy Steels," is available on request.



Heavy duty axle. Scammell Lorries Ltd

THE FIRTH-DERIHON STAMPINGS LIMITED, SHEFFIELD



For 1960

THE AUTOMOTIVE PRODUCTS GROUP

looks forward to playing an
even fuller part in the continual
progress of the Industry

LOCKHEED DISC

Regd. Trade Marks LOCKHEED.

LOCKHEED HYDRAULIC BRAKE COMPANY LIMITED
LEAMINGTON SPA, WARWICKSHIRE

OUTSTANDING ADOPTION OF LOCKHEED DISC BRAKE SYSTEM

Conforming to our policy, followed since the inception of our hydraulic brakes, we conducted a considerable amount of research, exploring different types of disc brakes and their detail design, and ultimately focused our conclusions upon one basic design.

This design, adaptable to suit the disc brake requirements of individual cars, has been adopted in one or other of its variants by Britain's biggest car manufacturers, and by specialists producing sports cars.

STABILITY & HIGH PERFORMANCE

Lockheed disc brakes, made to the same high standards of material and workmanship as the drum brakes that have made Lockheed famous, develop to the full the qualities of stability and high performance that are characteristic of the disc brake at its best. The brakes are self-adjusting.

HIGH-VOLUME PRODUCTION

The basic simplicity, characteristic of Lockheed productions, permits high-volume manufacture combined with close limits and strict interchangeability.

THE LOCKHEED POWER BRAKING UNIT (*shown on left*)—
the best of its kind—is available in two sizes, to suit all cars.

WOLSELEY
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AUSTIN
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MGA
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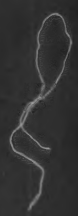

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SOME OF THE NEW DEVELOPMENTS OF BORG & BECK

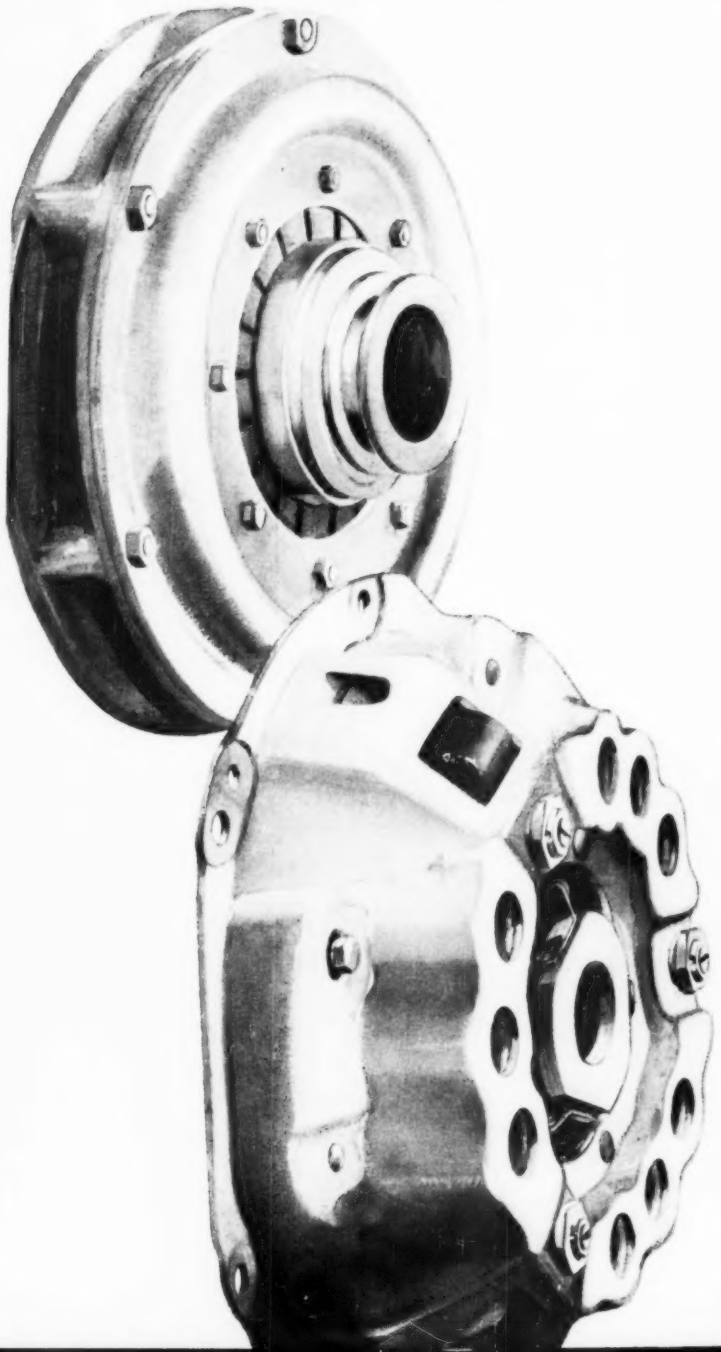
7¼" 'DIAPHRAGM' TYPE RACING CAR CLUTCH

This triple-plate clutch, designed expressly for competition and racing use, has the following special features:

- High torque capacity.
- Suitability for high r.p.m.
- Low inertia driven plates.
- Small overall dimensions and light weight.
- Ability to operate at high temperatures.
- Available with either 1, 2, 3 or 4 driven plates.
- Interchangeable as a unit with twin and triple plate Borg & Beck clutches previously used for racing.

8" AND 8½" STRAP DRIVE CLUTCH

This clutch embodies the successful self-centring frictionless strap drive to the pressure plate. The clutch can be installed in the same size bell housing used with the standard Borg & Beck 8" A.6 clutch, and the same types of flywheel and release bearing can be used. According to the nature of the application, the clutch can be used with either an 8" or an 8½" driven plate.



BORG & BECK CLUTCHES

Regd. Trade Mark: Borg & Beck

BORG & BECK COMPANY LIMITED
LEAMINGTON SPA, WARWICKSHIRE

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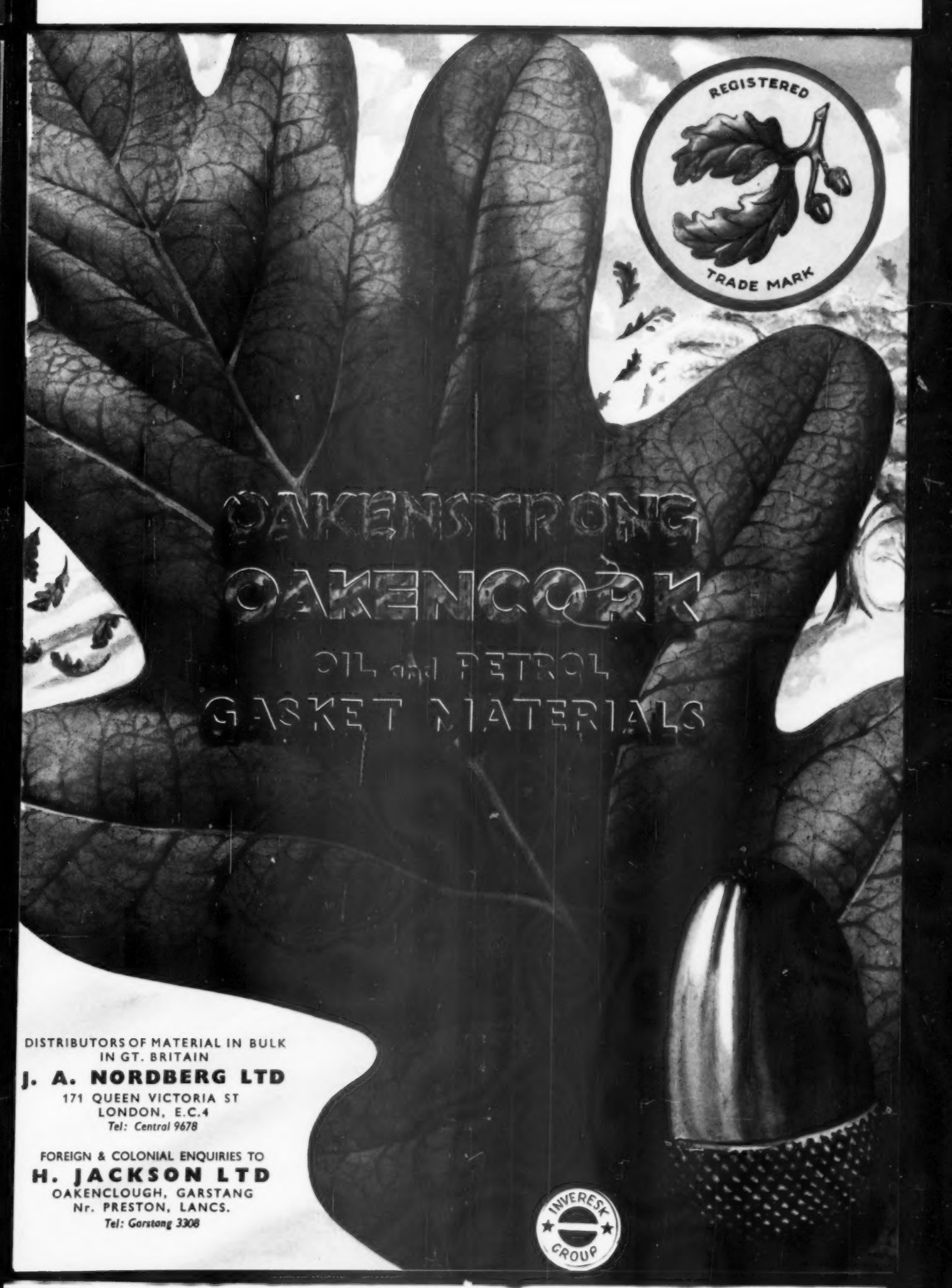
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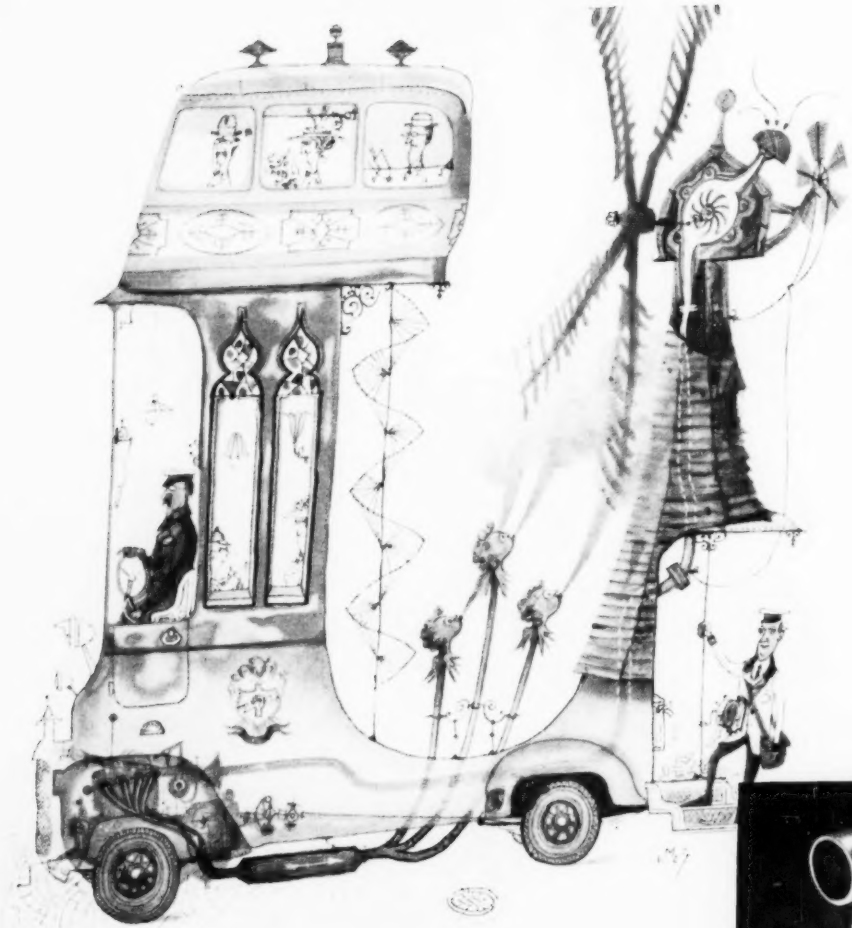

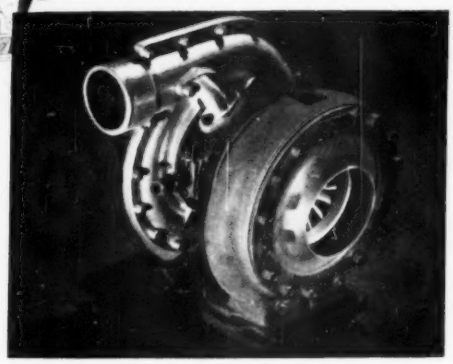

Turbochargers . . .

. . . the Emett and the Simms; Identical in principle; the difference is in their harking. The Emett harks back; to roads that, though dusty, could still be called open without raising a laugh; to summers that were always hot and drowsy; to motor cars that looked like grandstands or curio cabinets; to F. R. Simms himself, bowling through the English lanes in his latest Simms-Welbeck tourer, scattering pigs and chickens and sending bewildered, fist-shaking farmers scrambling into the hedgerows. Even in those days *he* was harking forward.

Summers are not what they were. Motor cars look like frustrated space ships. Chickens have grown so used to tractors that they have been known to nest in them. But machinery *works* much better. What the Simms-Eberspacher turbocharger lacks in romantic charm it gains in efficiency. It is made by a company with a long history of harking forward.

Simms

SIMMS MOTOR UNITS LTD. LONDON, N.2

DOW PLASTICS *for automobiles*

CONTRIBUTE PRODUCTION ECONOMY AS WELL AS BEAUTY

For every application involving plastics in the modern car, there's a special-purpose Dow plastic that will do the right job. Dow thermoplastics make valuable contributions in terms of beauty, function and durability, as well as those all-important production economies!

There's Zerlon* 150, for example, one of the newer Dow plastics. It's crystal clear and displays excellent light transmission properties . . . has high strength and resistance to shattering . . . is exceptionally easy to fabricate. Saran* fibres are ideal for upholstery — they're durable, colour fast and easy to clean.

For facts and figures about the wide range of plastics, as well as antifreeze and brake fluid, which Dow supplies to the automotive industry, contact your local Dow representative or branch office, the addresses of which are listed below.

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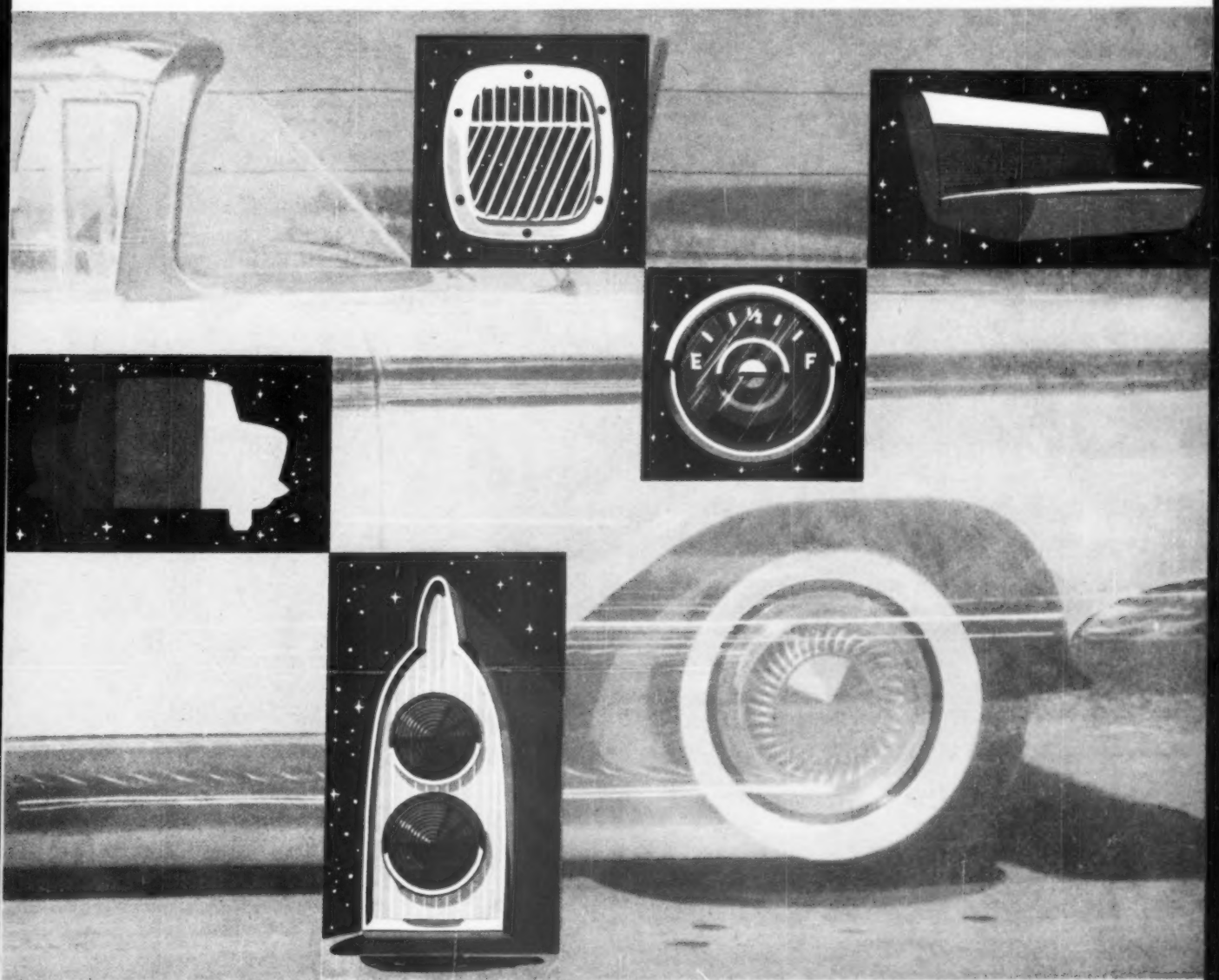

LATEX 566 for metal primers **TYRIL*** for car fittings **STYRON *440** for ventilating ducts **ZERLON 150** for dash board instrument lenses **SARAN** for seat covers, upholstery

Principal distributor of Dow Products in the United Kingdom
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BRITISH RESIN PRODUCTS LTD.,
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DOW CHEMICAL COMPANY (U.K.) LIMITED
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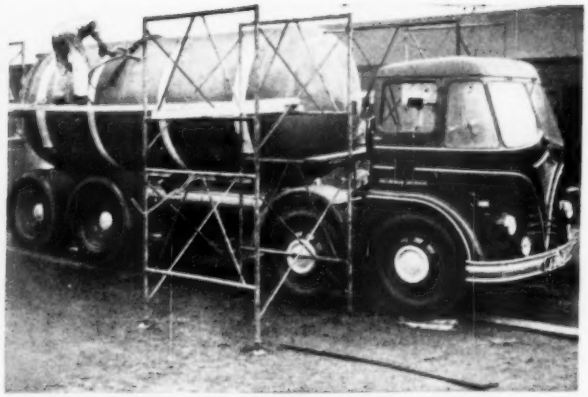

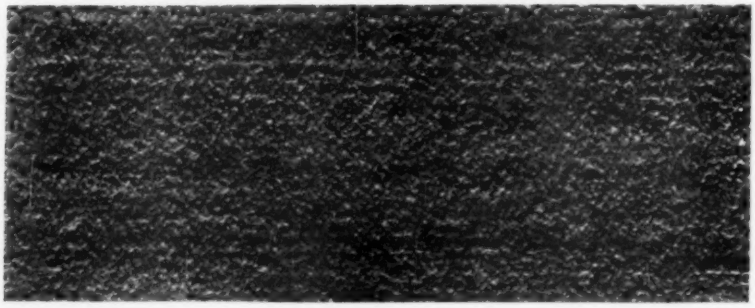

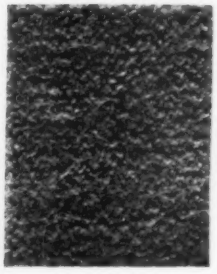

Transport Insulation with

Polyurethane rigid foams

made from I.C.I. ISOCYANATES AND POLYESTERS

Ask for details of Daltolacs 21, 22 & 24 Ⓟ and Suprasec D Ⓟ

Polyurethane foams provide excellent thermal insulation in all transport vehicles. They combine high thermal resistance with lightness, strength and low inflammability. Polyurethane foam components can be mixed on the site and poured or sprayed into position. The foams withstand vibration and adhere so firmly to adjacent surfaces that they actually *strengthen* the structure in which they are employed.

Ⓟ Patented in the main industrial countries

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for the small saloon....

or the large truck.....

– cooling specialists since motoring began

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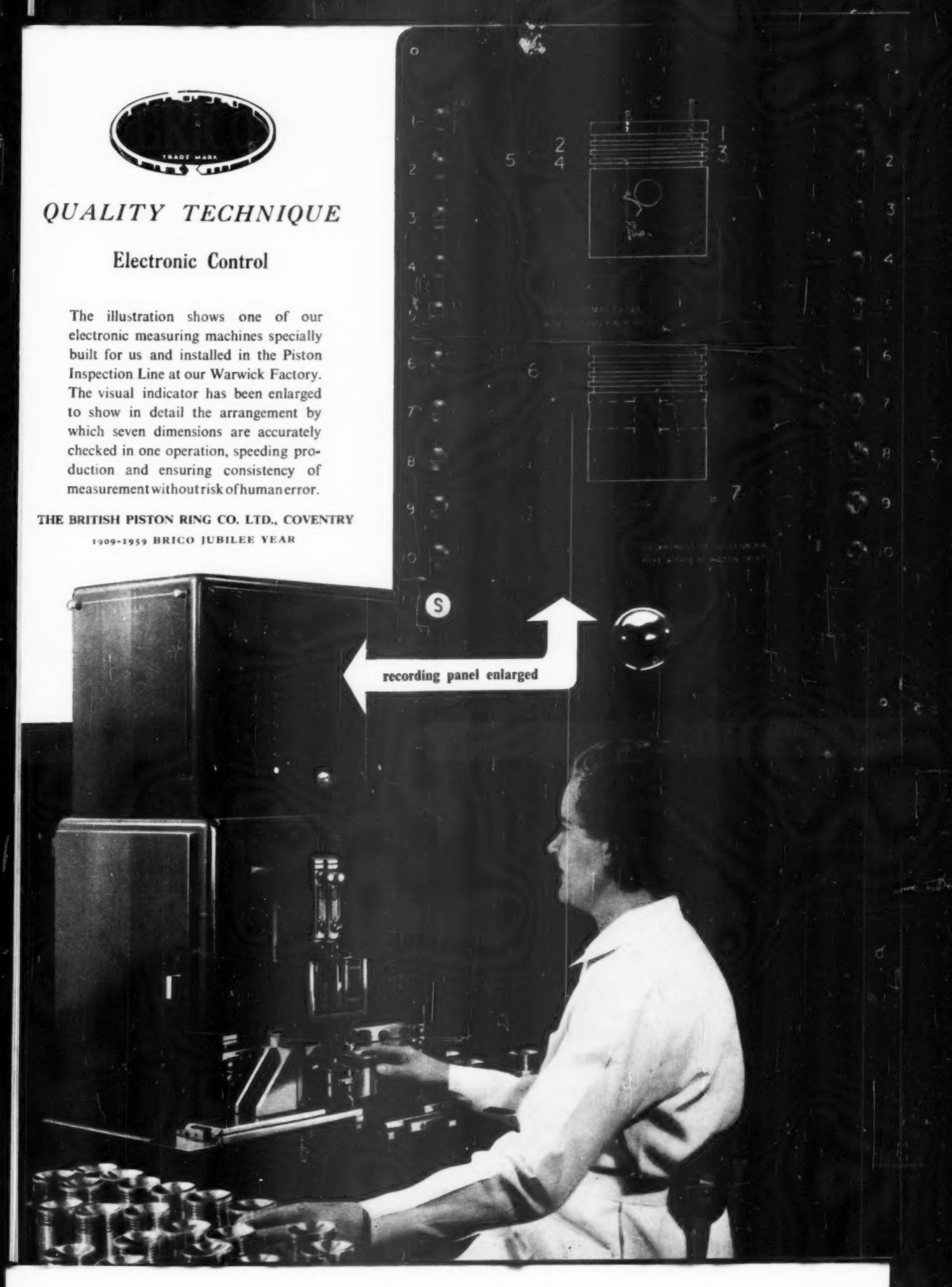
COVENTRY MOTOR FITTINGS CO. LTD

ESTABLISHED 1902



QUALITY TECHNIQUE

Electronic Control

The illustration shows one of our electronic measuring machines specially built for us and installed in the Piston Inspection Line at our Warwick Factory. The visual indicator has been enlarged to show in detail the arrangement by which seven dimensions are accurately checked in one operation, speeding production and ensuring consistency of measurement without risk of human error.

THE BRITISH PISTON RING CO. LTD., COVENTRY

1909-1959 BRICO JUBILEE YEAR

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MINOR CABINET MACHINE

SIZE 2 CABINET MACHINE

SIZE 3 CABINET MACHINE

All hungry for work and ready to tackle all you put before them. They are not particular what they get whether it is engine parts or crank cases, gear wheels or castings. Powerful and accurate jetting action rapidly removes all the grease and swarf, even from many of those particularly difficult corners. And, this is why Dawson equipment is so widely used in car engine manufacture for cleaning cylinder blocks and other complex parts.

Whatever your problem our wide experience and extensive technical resources are at your disposal.

Dawson **DEGREASING AND CLEANING PLANT**

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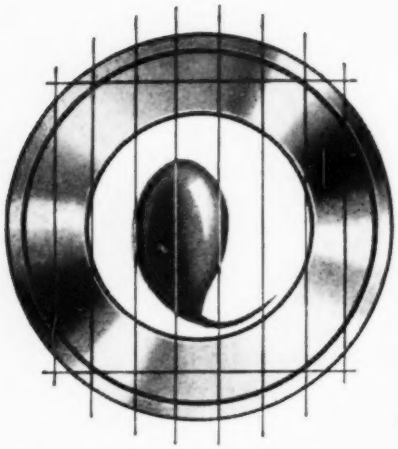
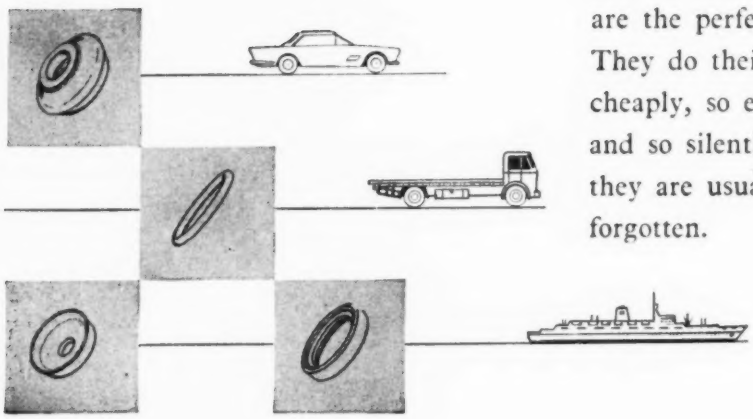
London Works: 406 Roding Lane South, Woodford Green, Essex. Telephone: Wanstead 7777 (4 lines)



Oil

is a difficult prisoner...

and it must be kept in
solitary confinement
too; no fraternisation
with that insidious
enemy dirt, either.
SuPerfect Oil Seals
are the perfect **gaolers.**
They do their job so
cheaply, so efficiently,
and so silently that
they are usually completely
forgotten.



SUPER OIL SEALS & GASKETS LTD.
FACTORY CENTRE, BIRMINGHAM, 30.

Manufacturers of 'SuPerfect' Hydraulic Packings and 'O' Rings; 'Romet' water pump seals and mechanical pump seals; 'Aeroquip' Flexible Hose with detachable re-usable fittings; 'Fidrac' mechanical rubber mouldings; 'Redcaps' Polythene Protective Caps and Plugs.

—reduce production times and costs in your sheet-metal dept., install—

ECKOLD PICCOLO

MODEL K.F. 653C

FOKKER-ECKOLD

sheet-metal shapers

A range of machines which provides a simple and rapid method of cold forming by the process of stretching and shrinking, mild steel, stainless steel, titanium, copper, brass or aluminium alloy into a variety of shapes, some of which are illustrated above.

Special tooling is available for profile forming, re-forming, pipe reducing, planishing, upsetting and flattening.

Models available:-

Type H.F.80, a hand operated machine with capacity up to ¼" (Aluminium) thickness.

Piccolo, a small versatile and mobile machine of medium capacity up to 14 S.W.G. (Brass) thickness.

Type K.F. 400 with a two-speed motor providing a choice of 300 or 600 strokes a min. Capacity $\frac{1}{16}$" (Aluminium) thickness.

Type K.F. 653C, the largest in the range with a choice of 150, 300 or 600 strokes per min.

ALFRED HERBERT LTD., COVENTRY *Factored Division, Red Lane Works.*

AD. 554


Who's behind

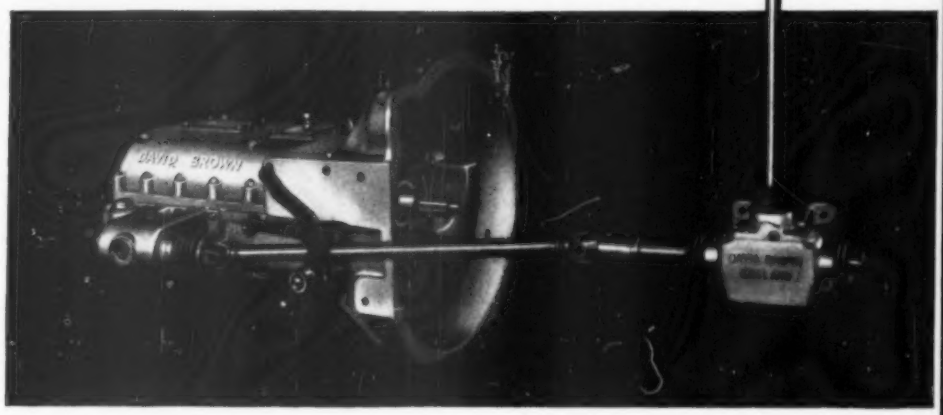
the man behind the wheel?

"A vehicle is only as good as its transmission." Some people might feel disposed to argue about this—but not anyone at the Automobile Gearbox Division of David Brown. We believe it. We live by it. We make it the basis of our business.

In the days when the internal combustion engine was fighting it out with the horse, David Brown were making gears and gearboxes. We are still making them—'standards' and 'specials'; by which we mean 'standards' that are special and 'specials' that are extra special. And we make them in a wider variety than you will find anywhere else in the country.

And so, when the man behind the wheel has behind *him* the name of David Brown, he can have confidence in the transmission. Every confidence. And this applies whether the vehicle in question is a lorry, a van, a bus, a tractor or a forklift truck.

MODEL 557/480
5 speed. Forward control. Constant mesh on all speeds. Maximum engine torque 480 lb./ft. Approximate weight 470 lb.



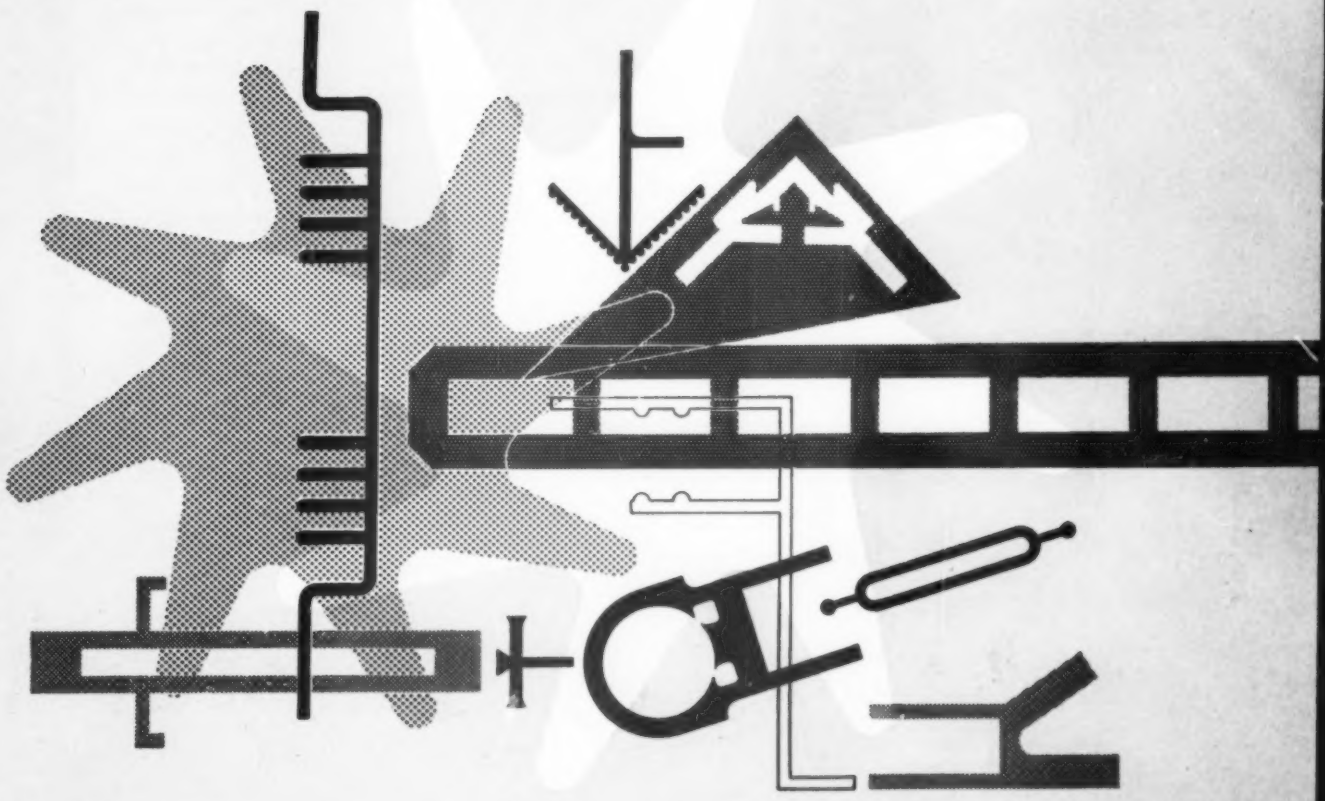
DAVID BROWN

THE DAVID BROWN CORPORATION (SALES) LIMITED

AUTOMOBILE GEARBOX AND GEAR DIVISIONS, PARK WORKS, HUDDERSFIELD. TEL. HUDDERSFIELD 3500

DA/5781

Is it "impossibly" complex?



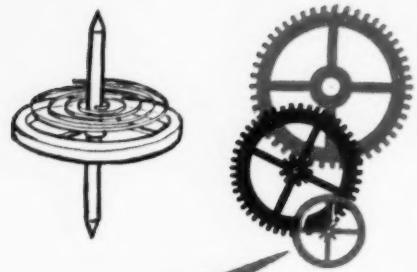
H.D.A. are uncommonly competent

Manufacturers in many fields—from automobiles to atomic power—know where to take their worst headaches: H.D.A. have a way with really disheartening problems that turns them into feathers in the caps of all concerned. Our Hiduminium extrusions are an example. They combine smoothness of surface and a uniformly fine, dense structure with the highest physical properties. They have solved many manufacturer's problems—thanks to the special treatments evolved by H.D.A. to make one of their Hiduminium alloys precisely suitable for a particular application. Problems like this are always cropping up. H.D.A. is always solving them.

Hiduminium

makes the most of *Aluminium*

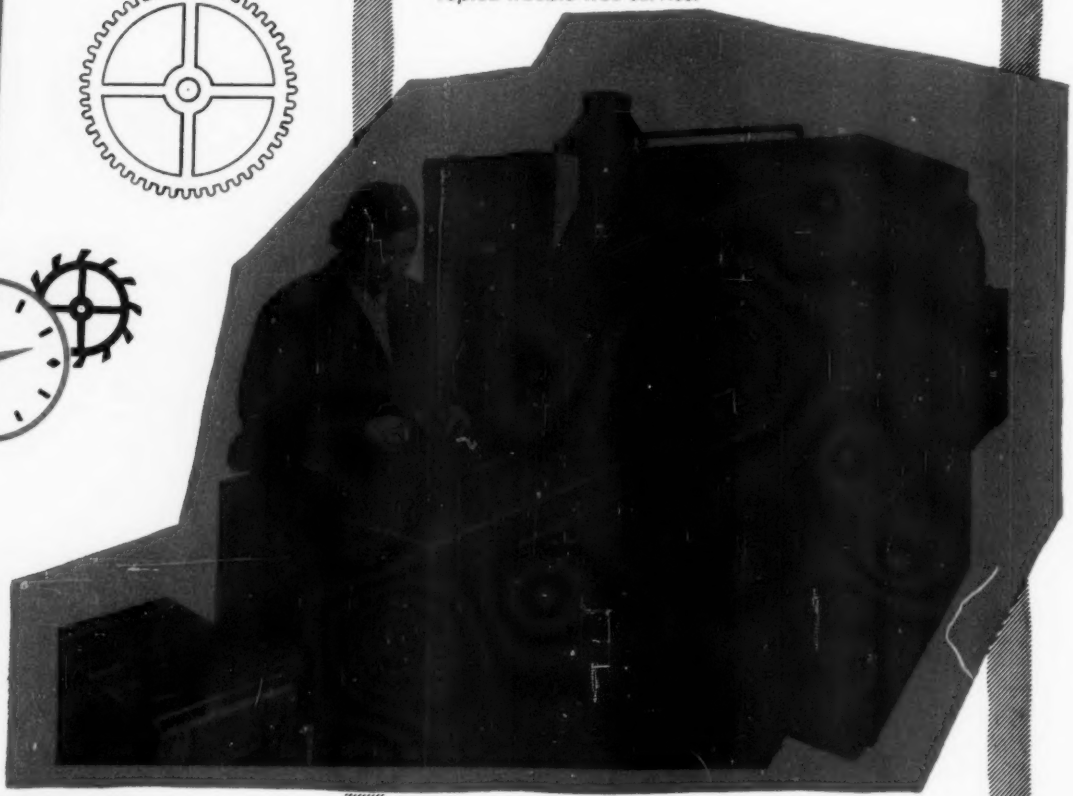
HIGH DUTY ALLOYS LTD., SLOUGH, BUCKS.



MAKING TIME

Here at the Wishaw factory of Smiths Clocks & Watches, a division of S. Smith & Sons (England) Ltd., they **make** time—or at least time pieces. Manufacturing a large proportion of Smiths clockwork alarms, industrial timers and domestic ringers, the factory produces some fifteen to twenty thousand units daily, over a quarter of which are exported. Four brazed components are fitted to each of these clocks and are brazed in a 20 kW Birlec mesh belt conveyor furnace. On the average the furnace works 18 hours a day for five days a week.

** The cost of a furnace is not necessarily its purchase price. Any interruption in production may cause serious losses in output, particularly in modern factories where stocks are deliberately streamlined. The purchaser of a Birlec furnace can be confident that the equipment will not only meet his specification but will give uninterrupted trouble-free service.*



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AEI-Birlec Limited

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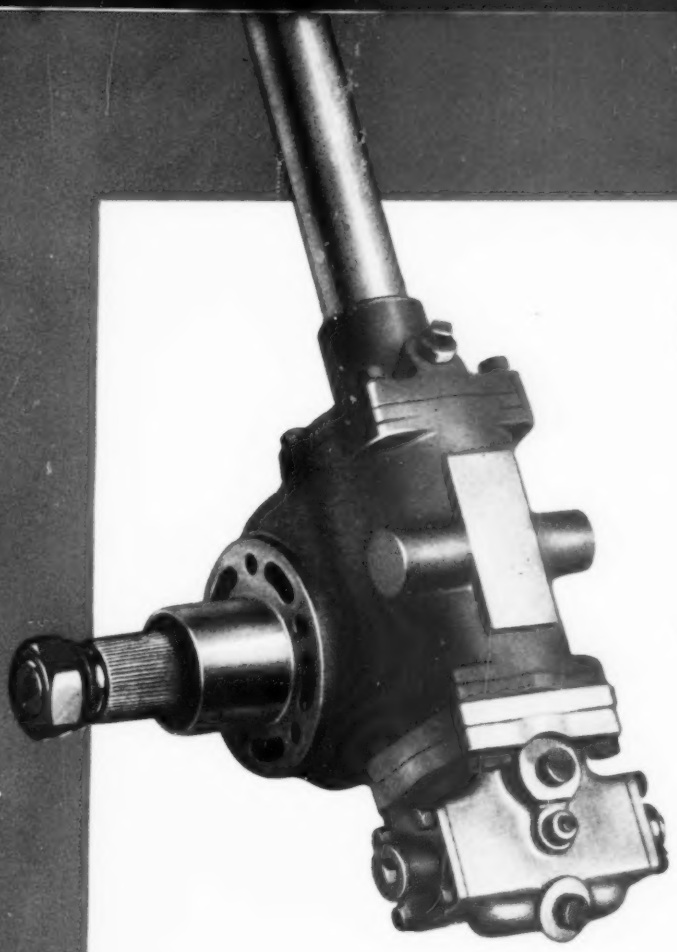


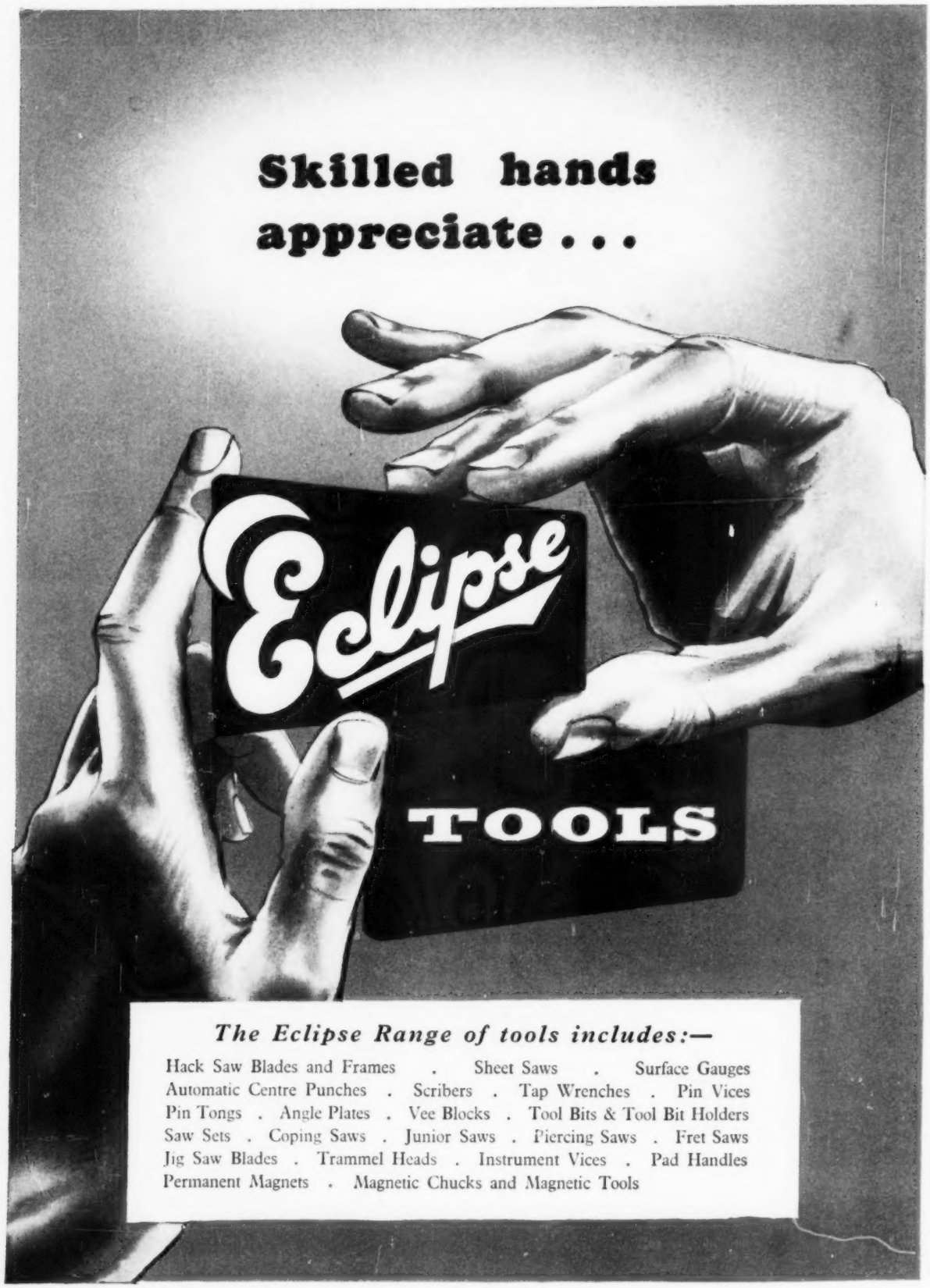
Interchangeable, on the same mounting, with the standard Marles manual gear unit.

THE TYPE 3 'UNIVERSAL' UNIT

Illustrated above is the Type 3 'Universal' steering gear which incorporates the hydraulic control valves mounted upon our type '861' manual gear. This is for use with a separate power pump and with power cylinders operating on the steering linkage. Further particulars will be sent on request.

ADAMANT ENGINEERING CO. LTD.,
THE AERODROME, WOODLEY, Near READING.
Sole proprietors of the Marles Steering Company Ltd.
Telephone: Sonning 2351 Telegrams: Adamant, Reading

MARLES



The Eclipse Range of tools includes:—

Hack Saw Blades and Frames . Sheet Saws . Surface Gauges
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Pin Tongs . Angle Plates . Vee Blocks . Tool Bits & Tool Bit Holders
Saw Sets . Coping Saws . Junior Saws . Piercing Saws . Fret Saws
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Permanent Magnets . Magnetic Chucks and Magnetic Tools

Made by James Neill & Co. Sheffield Ltd., and obtainable from all tool distributors

UX13

SUSPENSION UNITS

for the HEAVY VEHICLE

HEAVY-DUTY CONE BUSHES

Accommodating pivotal movements such as those in suspension linkage and spring pivots, these bushes are relatively free torsionally, adding but little to the spring stiffness. They are very stiff axially and radially and support heavy loads.

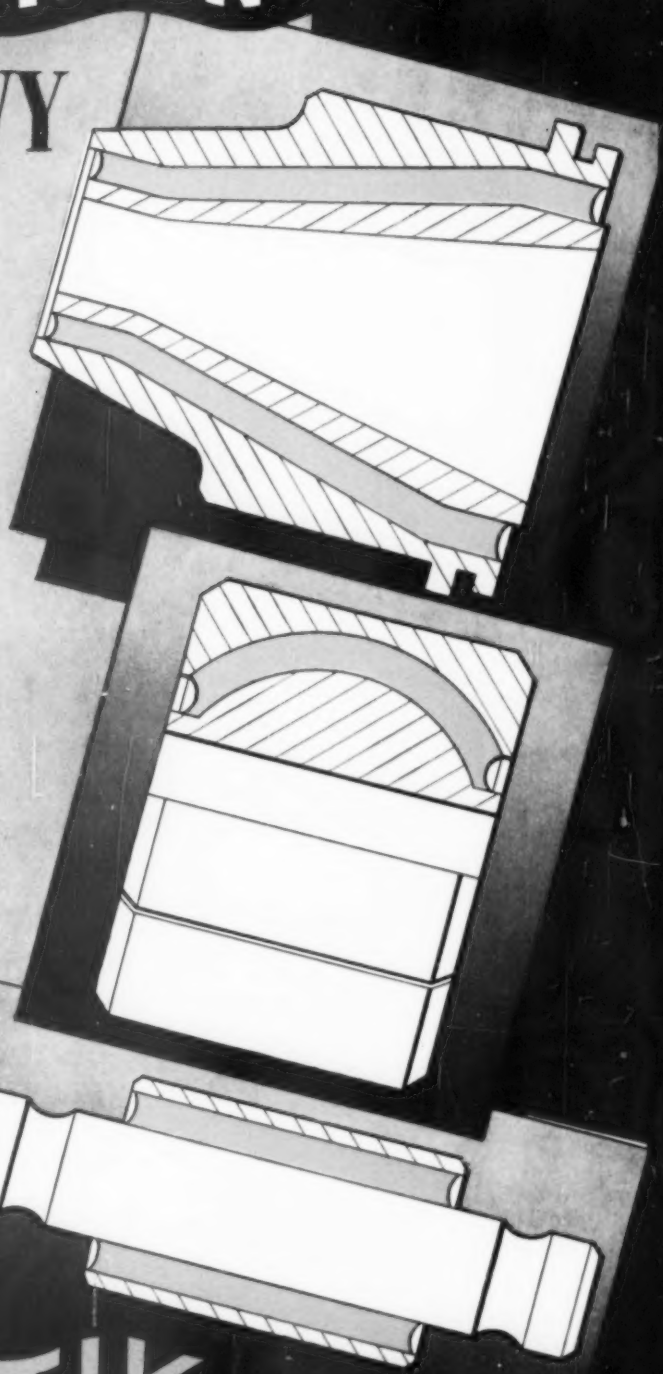
SPHERILASTIK BEARINGS

Permitting universal pivotal movements combined with large loads, Spherilastik bearings are being used with great success on a number of new suspension systems. Rubber is bonded to the spherical inner member and to the outer member which is in three segments. Force-fitting in the housing pre-loads the rubber to increase life and load capacity.

ULTRA-DUTY SHACKLE PINS

These are made in two types, one as illustrated and the other a still heavier duty type. They are giving amazingly long mileages in spring shackles on heavy vehicles.

Whatever your suspension, transmission or vibration problems may be, our engineers are always at your disposal.



METALASTIK

METALASTIK LTD., LEICESTER

HARPER CAST DIES

overcame this pressing problem with a handsome margin to spare!

British Moulded Plastics Ltd. had to be in production within 12 weeks on this instrument housing for the Ford Motor Company. The job necessitated a single cavity compression mould – normal steel tools cut from solid forgings would take 18/20 weeks to produce . . .

. . . so Harper Cast Dies were ordered for the interim tooling and were ready in 6 weeks; tools were available for sampling within the scheduled 12 weeks! Of two Harper dies tooled in September '957 one was still in production in mid-July 1959. The total number of mouldings pressed was then 121,030, the greater percentage of these by the tool still in use.

Although the cost of the Harper Cast Dies was higher than that of steel moulds, the tooling costs of the castings were approximately half and the mouldings were produced to programmed schedule.

HARPER CASTINGS

Harper quality covers Grey Iron, Spheroidal Graphite Iron (Mond Nickel Licence) and Meehanite castings. Metal pressings, machining, enamelling and sub-assembly work.

The word MEEHANITE is a registered trade mark.

Also makers of the famous Beatrice Oil Heaters and Harper Housewares.

It pays to consult Harpers when you need prompt service and top quality

Please write for our chart, which gives technical information on our mixtures.

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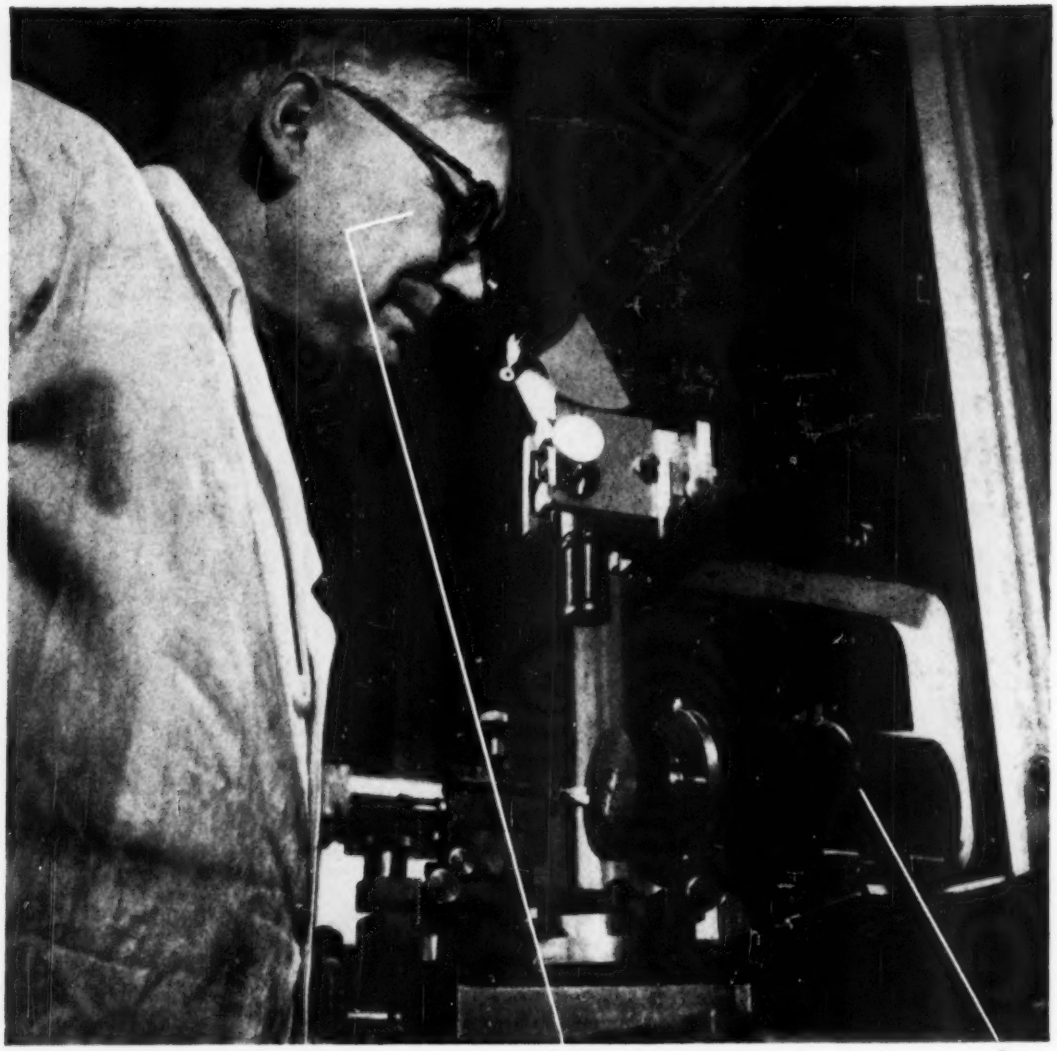

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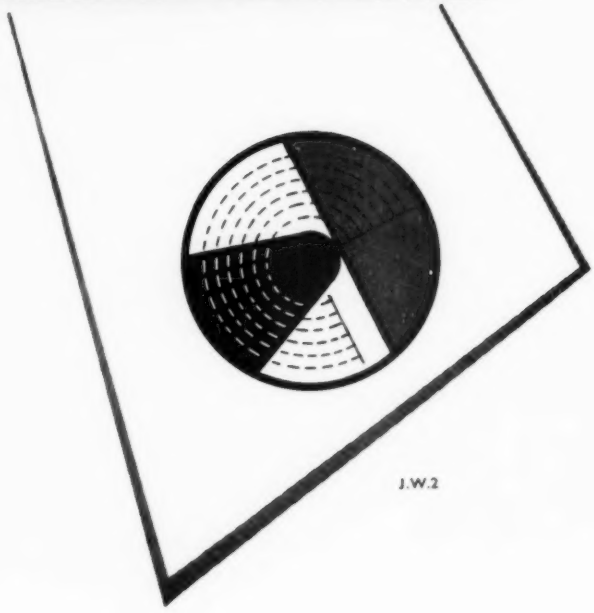

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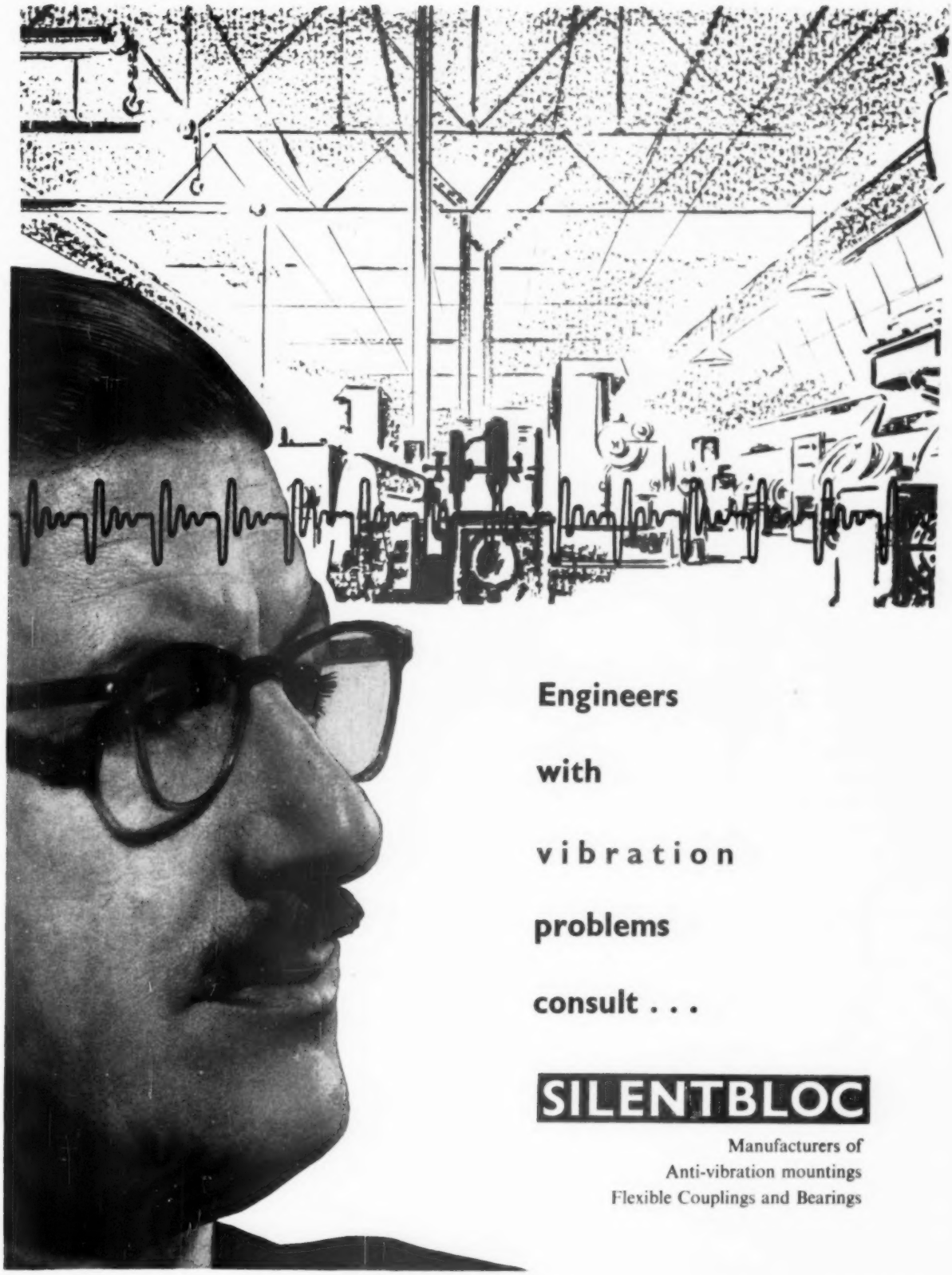

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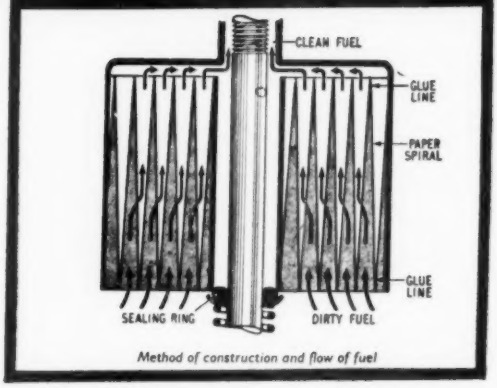

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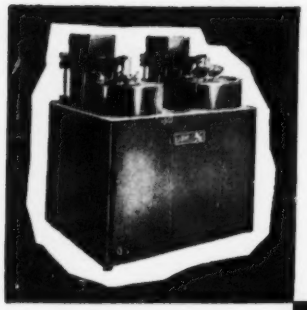

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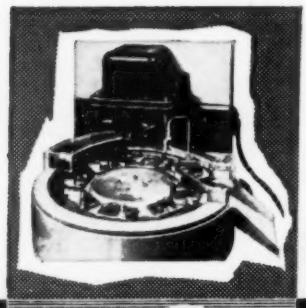

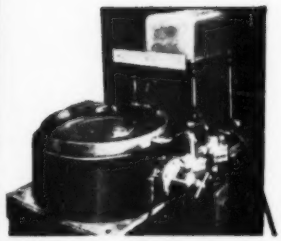

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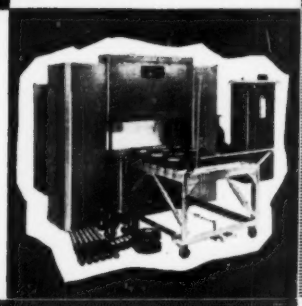

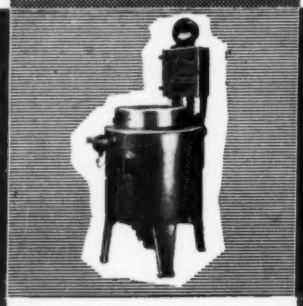

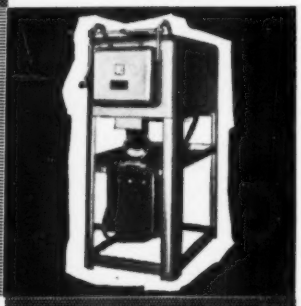

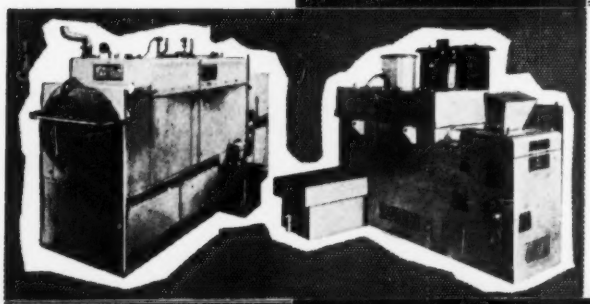

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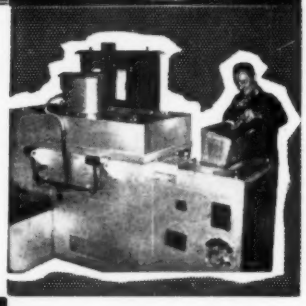

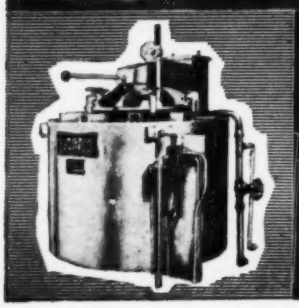

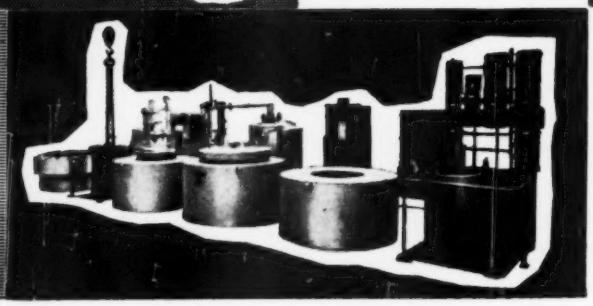

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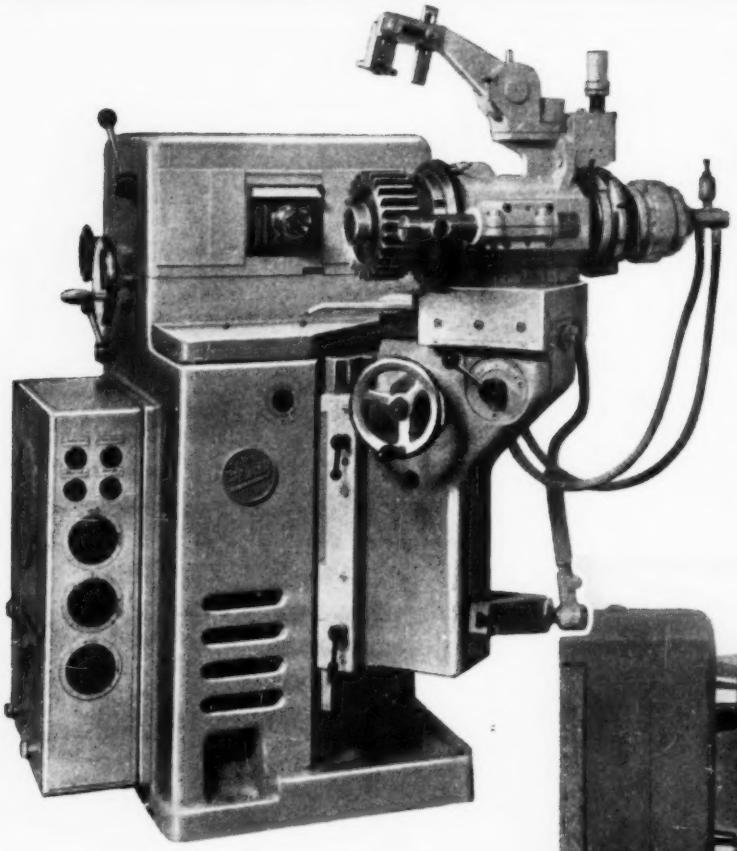

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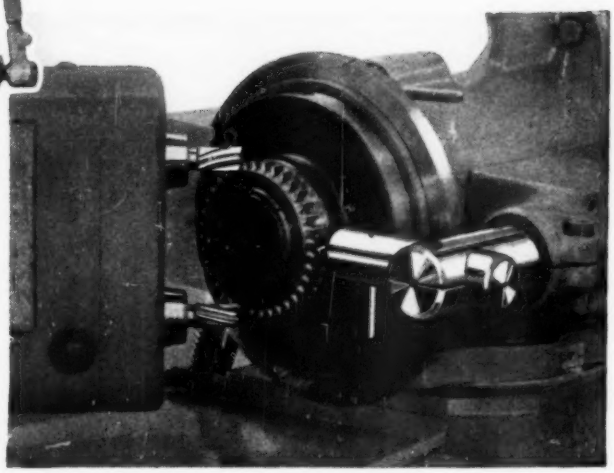

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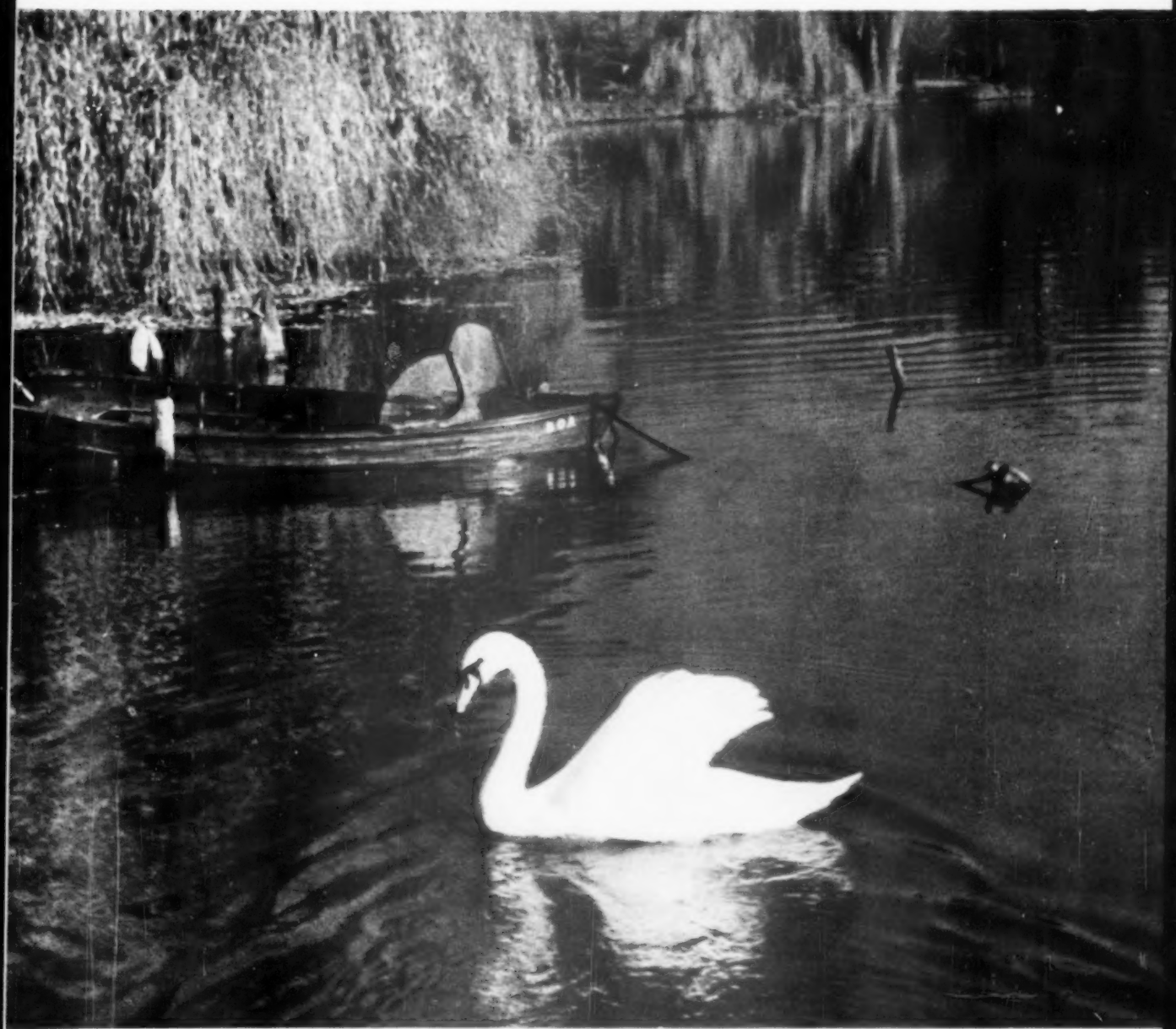

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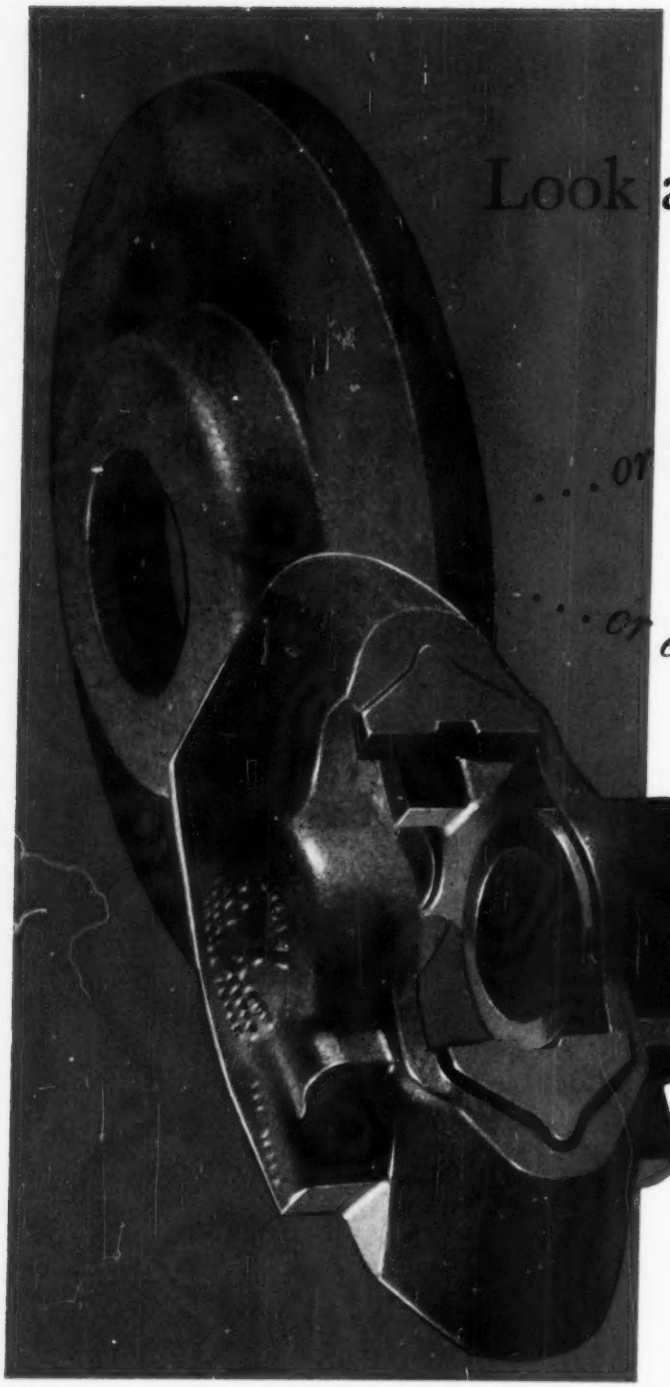

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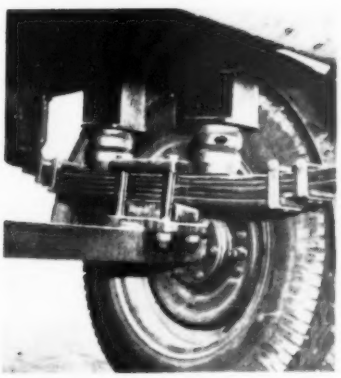

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DESIGN MATERIALS **AUTOMOBILE ENGINEER** PRODUCTION METHODS WORKS EQUIPMENT

Co-operation Needed For Faster Progress

WERE it not for the effective co-operation already achieved between companies and industries, progress would of course, be much slower and more costly. However, there is still scope for improvement: an even greater rate of advance could be attained by closer co-operation between the vehicle manufacturing industries and those concerned with component manufacture and the processing of materials used in the construction and operation of vehicles. The need for bringing all available information to bear in the solution of engineering problems was emphasized in a paper recently delivered, to the Automobile Division of the Institution of Mechanical Engineers, by Leonard Raymond, President of the Society of Automotive Engineers, and Chief Automotive Engineer, Research, Socony Mobil Oil Co. Inc., New York.

Many instances can be quoted to illustrate the need for a common approach to engineering problems by different manufacturers. For example, the trend towards the employment of larger valves, to obtain better breathing, calls for the use of heavier valve springs, particularly in view of the fact that there is also a tendency for maximum speeds of engines to be increased; in addition, cam contours are, of course, being developed to give more rapid opening and closing of the valves. As a result of these advances, pressures between cams and tappets are tending to become higher than ever before, and difficulties are being experienced in the form of pitting, spalling, scuffing and accelerated wear.

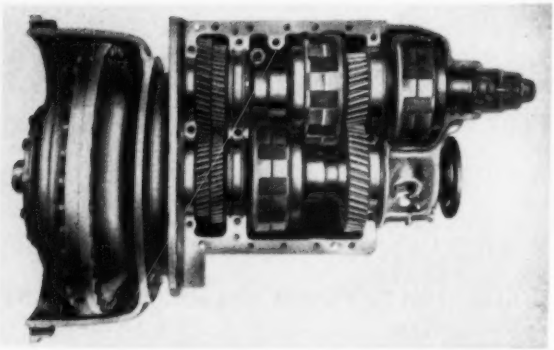
Obviously, this problem is primarily one for the engine designer and development engineer, who can deal with the mechanical aspects but, equally obviously, it also concerns the material suppliers. Some car and commercial vehicle manufacturers have sought to overcome their difficulties by using materials such as hardened alloy irons, whilst others have employed steel for camshafts and tappets. These measures may be necessary in certain circumstances, but they can introduce other problems. For example, lubricants that are satisfactory with one combination of metals may not be suitable for use with another. It is, therefore, essential for the oil industry to be brought into consultation, for it is important to avoid, if possible, adding yet another grade of lubricant to the already wide range that has to be stocked in service stations. It would be ideal if the metallurgists, designers and lubrication specialists could agree on rationalization in the different fields.

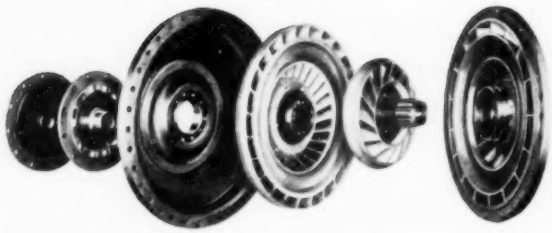
There remains a great deal to be learned about the interaction of surfaces, in relation to scuffing, wear and friction. In this connection, yet another branch of science and industry should be consulted: isotopes or radioactive tracers are now being employed widely, but an even newer means of investigating the chemical composition of surfaces involves the use of reflected protons.

Many automatic transmissions incorporate multi-plate clutches, instead of dogs, for the engagement of the gears. The principal requirement for these components is smooth, noiseless and constantly reliable shift under all conditions of operation. Of these, perhaps the most important factor is the consistency of clutch engagement, and this concerns manufacturers not only of the transmission but also of facing materials and lubricants. Since the ultimate engagement of the clutch discs occurs under conditions of partial, or boundary lubrication, comments made in the preceding paragraph are also pertinent to this problem.

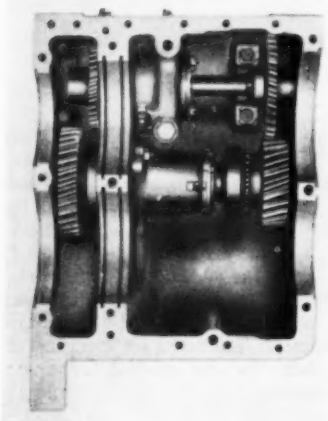
One of the difficulties that has to be faced with automatic transmissions is the relatively high oil temperatures—in the region of 350 to 400 deg F—that may be attained. This calls for the employment of anti-oxydant and anti-acid additives and of viscosity improvers. It also concerns the manufacturers of seals: some of the low cost elastomers currently used have a limited life under high temperature conditions of operation; other materials, of course, are adversely affected by certain additives in lubricants, and it is, therefore, imperative that vehicle and seal manufacturers, the suppliers of the synthetic materials from which the seals are made and the oil companies work together on this problem.

Temperature is also becoming an increasingly important consideration in respect of axle design and performance. It seems likely that new gear steels having higher hot strength and less subject to surface decarburization, and annealing at temperatures above 250 deg F, may be required. This will pose problems for the lubricant suppliers, who will probably be required to find a means of combining anti-weld properties with better thermal and chemical stability at high temperatures. Another development that may occur is the more widespread introduction of limited-slip differentials. Since many of these incorporate clutches, the lubricants employed would have to be such as to minimize stick-slip action in these components. Unfortunately, lubricity additives employed for this purpose tend to reduce the effectiveness of the anti-weld agents. Evidently, therefore, designers will have to evolve mechanical arrangements that do not make such large demands in respect of anti-weld qualities of lubricants. The position might be alleviated by the employment of special surface treatments or coatings, even if only for running-in.





Sub-assemblies of modern ZF gearboxes: above, the top portion of the casing, with the mainshaft, layshaft and torque converter, of the 3HM-60 gearbox; below right, lower portion of the casing with the reverse gear and oil pump assemblies; above right, 2HM-60 torque converter



ZF GEARBOX DEVELOPMENT

Evolution of a Range of Gearboxes in which the Speed Changes are Effected by Means of Multi-Plate Disc Clutches

FOR many years, Zahnradfabrik Friedrichshafen A.G. has been producing high quality transmission assemblies for commercial vehicles and tractors, as well as other equipment, such as steering gear, special purpose clutches, freewheels and marine gearboxes. An interesting section of their work has been the development of a range of gearboxes, incorporating multi-plate disc clutches for speed-changes, suitable for application to heavy commercial vehicles and railway power units.

Although the multi-disc clutch occupies a greater amount of space than a dog clutch and synchro-mechanism, its employment offers several advantages. One is that, provided the gearbox is used in conjunction with a fluid flywheel or torque converter for starting from rest, the clutch pedal can be obviated. Furthermore, with the type of control used, gear shifts can be made easily and without calling for any particular degree of skill on the part of the driver. Last, but not least, upward changes can be made almost instantaneously when the control is operated: this is particularly important on the long, steep, winding mountain roads in parts of Europe. Ability to make, and hold, upward changes on gradients, after temporary checks, may make a difference of as much as 25 per cent in the operating time of a coach, compared with one which, because of an awkward gear-change, is condemned to continue for miles uphill on a gear that is lower than the circumstances require.

In the earliest gearboxes of this type, which were introduced in 1938, the clutches were electro-magnetically actuated. However, it was decided that the possibility of failure of the transmission, as a result of an electrical defect, should be obviated. The next stage was the introduction of a box in which the clutches were engaged mechanically by means of a system of levers actuated by a cam drum, the drum being rotated by an electric motor. With this system, any electrical failure leaves the particular gear in use fully engaged; this is particularly important in mountainous districts, where the engine is invariably used as a brake on downward gradients. Provision was also made whereby, with the vehicle at rest, any desired gear or neutral can be obtained by removing a cover, inserting a tommy bar into a capstan head, and rotating the cam drum manually. Thus, in the event of failure of the electrical control gear, the vehicle can still be driven back to its depot.

Another advantage of the electro-mechanical system is that the load on the batteries is greatly reduced. Instead of the continuous, and considerable, energization current taken by the magnetic clutches, no current passes during normal running. The fairly heavy current taken by the gear-change motor lasts for only a fraction of a second during the gear-change.

It became obvious that this system could be further improved by the employment of hydraulic actuation of each clutch, the hydraulic valves being controlled electrically. This greatly reduced the demand on the electrical system of the vehicle, since the actual power for clutch actuation is supplied by mechanically-driven hydraulic pumps incorporated in the gearbox mechanism. Another advantage of the new arrangement is that the time required for engagement of the clutches is reduced.

So far, this principle has been applied only to the two- and three-speed Hydromedia boxes, used in conjunction with a torque converter, for buses; the six-speed Media unit still incorporates an electrically actuated cam-drum-and-lever operated gear shift system, used in conjunction with either a fluid flywheel or conventional clutch for starting from rest. In the first application of the principle of

hydraulic actuation, the hydraulic cylinders were separate castings bolted in the gearbox, and actuating levers similar to those employed with the cam drum. At the time of its introduction this, of course, was the most economical way of putting into effect the new arrangement.

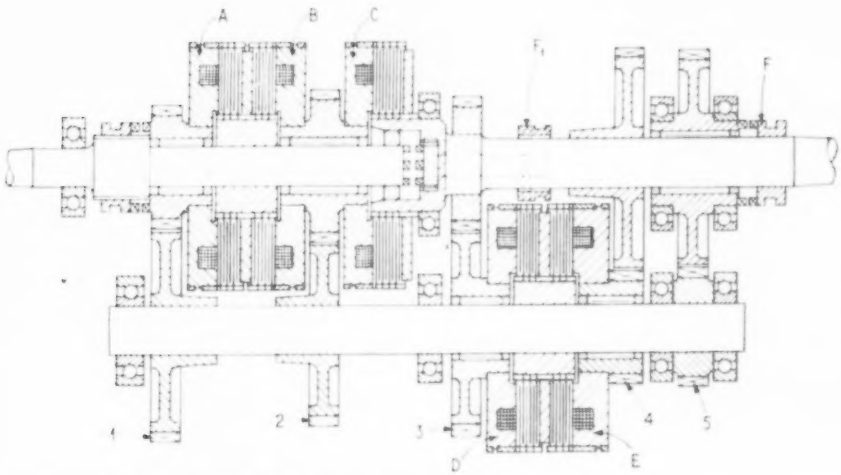
The next stage in development obviously was to incorporate each hydraulic cylinder in the casting that houses the clutch that it actuates. In this way, the mechanical linkage could be obviated, and the whole arrangement made more compact and positive in operation. Because fewer moving parts are used, the possibility of trouble as a result of wear, and other servicing defects, is reduced.

Recently, a fully automatic, electrically controlled system has been developed for application to the two-speed gearboxes. Basically, it comprises a throttle-actuated switch, which provides the torque sensitive element, and a small electric generator, used as the speed sensitive element, both feeding signals to a transistorized control box. The manual control is retained, but only to override the automatic control if necessary. An important advantage of this system is that, being transistorized, the control box is very compact. Its dimensions are 108 by 93 by 40 mm (4¼ by 3⅝ by 1⅝ in) and its weight is 560 gm (1·2 lb).

So far as the gearbox itself is concerned, the clutches are fully capable of dissipating the energy associated with an upward or downward change. However, as has already been stated, the start from rest is made with a torque converter in the case of the two- and three-speed gearboxes, and a fluid flywheel, or conventional clutch, with the six-speed units, the appropriate gearbox clutch being previously fully engaged. In the two-speed box, the take-up from first to second speeds is instantaneous, because a freewheel is incorporated in the first-speed gear system and this is overrun when the second-speed clutch is engaged, the first-speed clutch remaining in engagement. This arrangement, of course, is not used in the three-speed box.

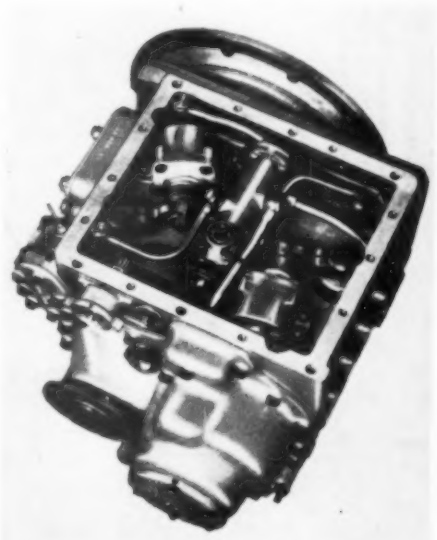
Basically, the principles of operation and of construction are similar for the two-, three-, and six-speed boxes. Therefore, only the two-speed, Hydromedia unit, will be described in detail, and reference will be made to the additional features in the three-speed unit; the arrangement of both these boxes can be seen from the accompanying illustrations, and the six-speed, Media unit was fully described in the January 1954 issue of *Automobile Engineer*. It is of interest to note, that, in the six-speed unit, two layshafts are employed. They can be arranged either vertically above and below the mainshaft, or on each side of it, according to the requirements of the installation. The reason for the use of two layshafts is, of course, to reduce to a minimum the overall length of the gearbox assembly.

In general, the Hydromedia transmission consists of a torque converter, which transmits the drive from the engine to a two-, or three-speed, layshaft type gearbox, in which the speed-changes are effected by means of multi-disc clutches. The advantages of the arrangement are as follows. Starting from rest can be effected smoothly, without making any demands on the skill of the driver. This not only is advantageous from the point of view of the passengers' comfort, and reduction of driver-fatigue, but also it reduces the wear and tear on the transmission system.



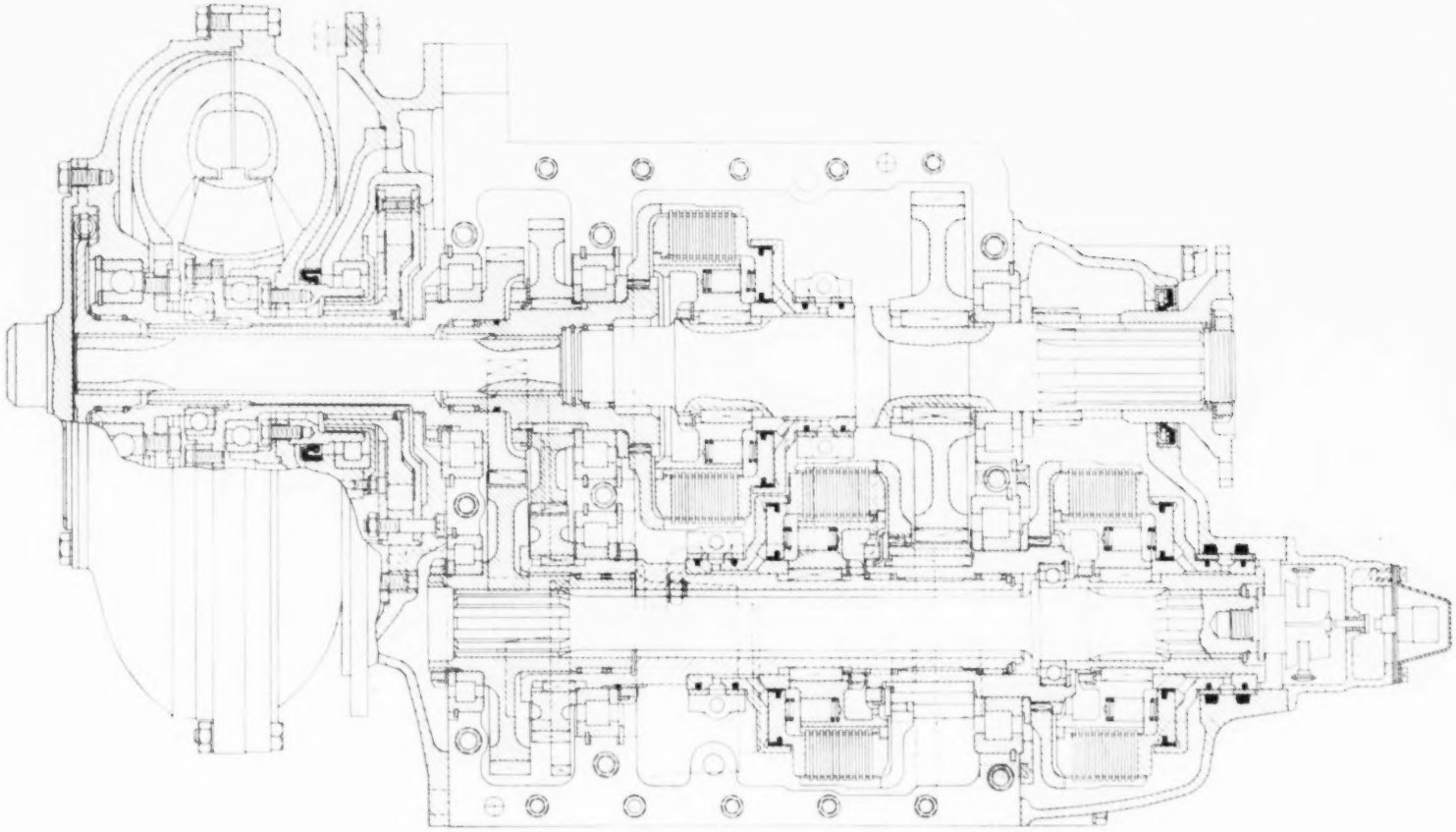
These three illustrations show the early stages in the development of the ZF range of gearboxes. In the first, depicted on the left, the clutches were electro-magnetically actuated. The next stage was the employment of a cam drum, which is shown above, to actuate the clutches; in this way the drain on the electrical system was greatly reduced. Below: further reduction in current consumption was achieved by the employment of hydraulic actuating cylinders

Key to the illustration on the left: A, B, C, D and E electro-magnetic clutches; F and F1 dog-clutches for operation in the event of failure of the electro-magnetic clutches. First gear, ratio 5·46 : 1, clutches A and E, and gears 1 and 4; second gear, 2·98 : 1, B and E, and 2 and 4; third gear, 1·83 : 1, A and C, and 1 and 2; fourth gear, 1·32 : 1 A and D, and 1 and 3, fifth gear, 1 : 1, B and C engaged



GENERAL ARRANGEMENT OF THE MAIN SHAFT, LAYSHAFT AND TORQUE CONVERTER ASSEMBLIES OF THE 3HM-70 GEARBOX

The layout is similar to that of the 2HM series of gearboxes except in that an additional clutch assembly is substituted for the freewheel unit, and the governor, for the prevention of downward changes when the engine speed is too high, is mounted on the tail end of the layshaft; also, the freewheel for the torque converter is accommodated on the front end of the gearbox instead of in the hub of the stator



Since the torque converter ratio is progressively varied automatically between the ratios of about 2·5 : 1 and 1 : 1 as the throttle pedal is depressed, this component takes the place of at least one, and possibly two, sets of gears in the mechanical part of the transmission. Also, the clutch pedal is eliminated and stalling of the engine is impossible.

By using the torque converter, it is thus practicable to employ an extremely simple gearbox. Two speeds are adequate for most town bus services, where the terrain covered rarely includes very long, steep gradients, and where maximum speeds are in any case limited by traffic conditions and legal restrictions. The three-speed gearbox, in conjunction with the torque converter, is suitable for most other types of operation of public service vehicles. Buses with this type of transmission are even operated with trailers on moderate gradients. For alpine routes, however, and for trucks, the six-speed, Media gearbox is recommended by the manufacturers, because a wider range of ratios is needed.

The three main components of the torque converter, that is, the impeller, turbine and reactor, comprise a closed hydraulic circuit, which is continuously supplied with oil under pressure from the gearbox. A roller type freewheel is interposed between the reactor, or stator, and its mounting on the gear casing. When the vehicle is first started from rest, the freewheel is locked, but when the speed reached is such that the torque ratio approaches 1 : 1, the reactor freewheels and the unit starts to operate as a simple fluid coupling. In this way, the efficiency of the unit is maintained at a relatively high value over as large a speed interval as possible. The performance characteristics and efficiency of the converter, used in conjunction with the mechanical gearbox, are shown in the accompanying curves.

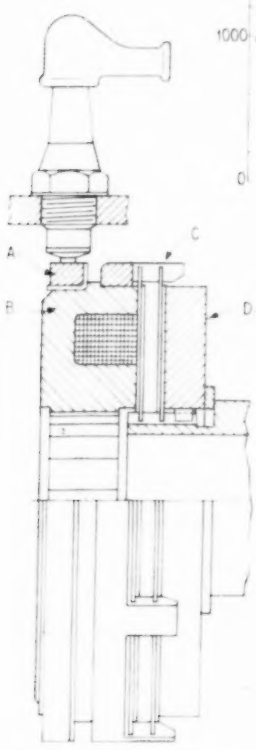
Even when the throttle pedal is fully depressed, for maximum acceleration from the stationary condition, the converter limits the engine speed to a value that ensures a high torque output. This not only increases efficiency, and therefore reduces fuel consumption, but also restricts engine noise. To prevent the transference of torsional vibration from the engine, through the driving component of the torque converter, directly to the gearbox and other parts of the transmission system, a number of coil springs are interposed between the driving component and the engine; the axes of the springs are arranged tangentially to a circle whose centre is on the axis of the input shaft.

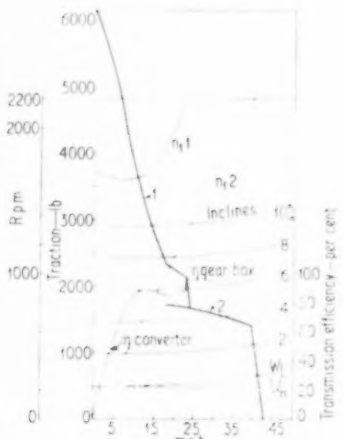
Gears and clutches

In the gearbox the two or three pairs of gears for the forward speeds are in constant mesh, and are helically ground to give quiet running characteristics. All are of DIN 20 Cr Ni 6 alloy steel. The transmission paths in the various gears are shown in the accompanying diagrams, and the gear ratios are listed in the table. To obtain the optimum torque output condition applicable to starting from rest, the first-speed ratio is, of course, multiplied by the

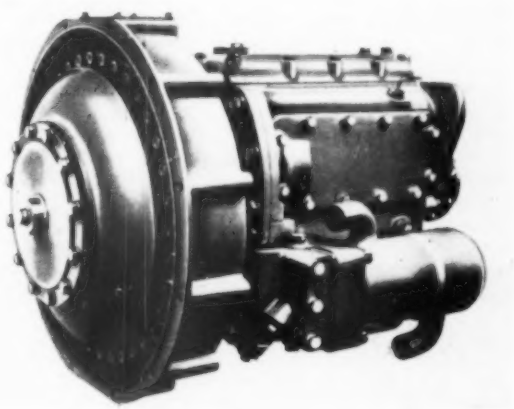
Below: Details of electro-magnetic clutch arrangement such as is used in the gearbox illustrated on the previous page

A *slip ring;* **B** *electro-magnet;* **C** *the multi-plate clutch; and* **D** *the presser plate component*

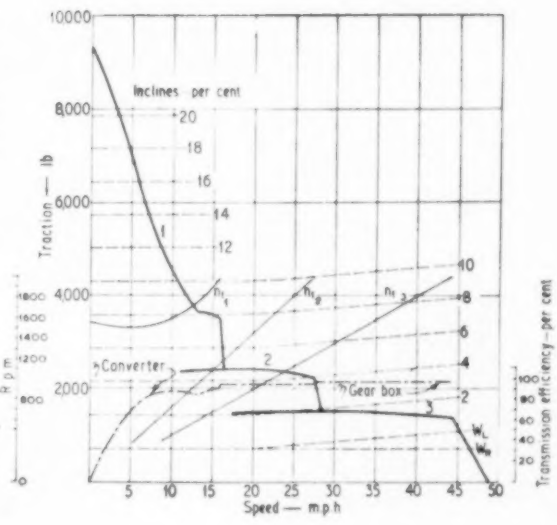




Above: Performance curves for a 2HM-60 gearbox with an engine developing a maximum power of 160 b.h.p. at 2,200 r.p.m. and a maximum torque of 448·5 lb-ft at 1,000 r.p.m., and with a rear axle ratio of 6·95 : 1, and tyres 1100-20 eHD on a vehicle whose laden weight is 11 tonnes



Above, right: View of the left-hand side of a gearbox, showing the oil cooler installation

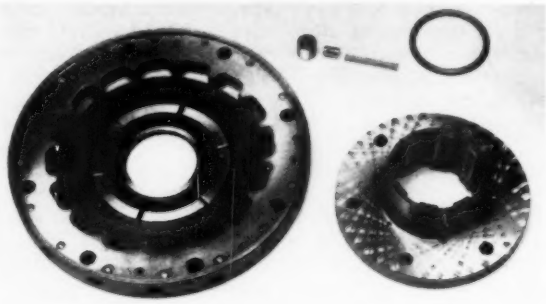


Right: Performance curves for a 3HM-60 gearbox with an engine developing a maximum power of 178 b.h.p. at 2,000 r.p.m. and a maximum torque of 507 lb-ft at 1,200 r.p.m., and with a rear axle ratio of 5·5 : 1, and tyres 1100-20 eHD on a vehicle whose laden weight is 15½ tonnes

Type	Duty	Max. torque input	Ratios							Weight	Oil capacity
		m-kg	*Torque converter*	*First speed*	*Second speed*	*Third speed*	*Fourth speed*	*Fifth speed*	*Sixth speed*	*Reverse*	*kg*	*litres*
2HM-70	Town service	70	2·5	1·56	1·00	—	—	—	—	1·47	276	18
2HM-60	Town service	70	2·5	1·56	1·00	—	—	—	—	1·47	276	18
2HM-40	Town service	44	2·5	1·58	1·00	—	—	—	—	1·46	194	16
3HM-40	Fast routes	44	2·5	2·50	1·62	1·00	—	—	—	2·31	202	17
3HM-60	Fast routes	70	2·5	2·49	1·61	1·00	—	—	—	2·50	299	18
6M-75	Fast routes	88	—	5·52	3·66	2·30	1·56	1·00	0·66	5·13	345	13
6M-50	Fast routes	60	—	5·52	3·66	2·30	1·56	1·00	0·66	5·13	260	13
6M-50	Mountain routes	54	—	8·66	5·52	3·66	2·30	1·56	1·00	6·50 or 5·13	260	13

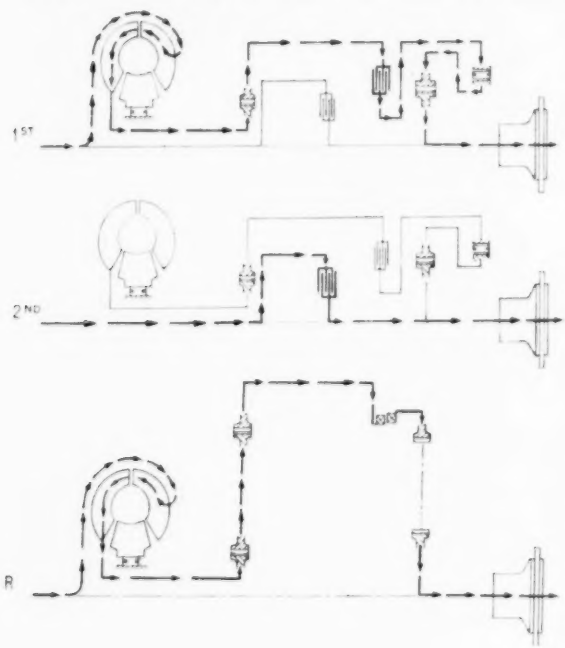
torque converter ratio. Thus the optimum value for the 2HM-40 unit is 3·96 : 1, that for the 2HM-60 and 2HM-70 transmissions is 3·90 : 1, while the ratio obtained with the 3HM-60 unit is 6·22 : 1. Similarly, the optimum values for reverse gear are 3·64 : 1, 3·68 : 1 and 6·25 : 1 respectively for these gearboxes.

The reverse gear idler and hydraulic selector assembly is installed in the base of the gearbox. It comprises two gears, one on each end of a common shaft, which is parallel to the main and layshafts. The smaller gear, which is on the output end, floats on the shaft and can be connected to the larger one by means of a dog clutch actuated by a hydraulic cylinder incorporated coaxially with the assembly. In the 3HM units, a compression spring is interposed between the engagement sleeve and the hydraulic piston, so that, even if the teeth of the clutch happen to be opposite one another when the gear is selected, the selection movement of the hydraulic piston is not halted and engagement is effected by means of the spring as soon as the dog teeth are correctly aligned with the slots. With the 3HM-60 unit, when the hydraulic pressure is released to disengage the gear, the return motion of the piston and sleeve is effected by another coil spring, which is interposed between the piston and one end of its cylinder. In the 2HM and the 3HM-70 and 3HM-40 gearboxes, however, hydraulic pressure, assisted by a spring, is used to effect disengagement, and there is not a spring interposed between the clutch and piston. The return-spring is retained mainly to prevent the dog clutch from creeping inadvertently into engagement in the event of failure of the hydraulic pressure in the system.



Above: Components of the freewheel unit of the 3HM-60 gearbox and, right, a view of the complete assembly

Below, left: Transmission paths, when the different gears are engaged, in the 2HM transmission units



The change-speed clutches have, of course, required more development work than any of the other components in the box. Their plates are manufactured from DIN C60 steel and are 1·2 mm thick. The inside and outside diameters of their friction faces are 118 mm and 173 mm respectively, in the 2HM-40, 2HM-60 and 2HM-70 gearboxes, and 135 and 189 mm in the 3HM-60 unit. In these boxes, the numbers of plates employed in each clutch are 13 pairs in the 2HM-40 and 3HM-40 units and 15 pairs in the gearboxes of the 60 and 70 series.

To reduce drag when the clutches are in the disengaged position, half of the plates are pressed into an undulated form, which gives a Michell bearing effect. The depth of undulation is 0·006-0·008 in. It is of interest to note that the clutches for the indirect gears are mounted on the layshaft, which, since it always rotates faster than the output shaft, transmits less torque. Although the centre components of the clutches are all hardened by heat treatment, the shells, which are machined from heavy pressings, are case-hardened on the edges of their slots to give good wear resistance locally.

The presser plate in each clutch is the hydraulic piston, which is returned to the disengaged position by means of a number of coil springs, in much the same way as is the presser plate in a conventional single-dry-plate clutch. These springs also prevent re-engagement of the clutches as a result of the action of centrifugal force on the residual oil in the cylinder. They are housed in holes drilled in the centre component of the clutch. There are two circular

seals of U-section on the hydraulic piston: one is round its outer periphery and bears against the bore of the cylinder, while the other is round its inner periphery and bears against a sleeve extension of the centre of the cylinder, where it is carried on the shaft.

Smooth take-up of the drive is ensured in three ways. The first is the incorporation of special devices in the hydraulic control to regulate the speed of engagement of the clutches. Secondly, the undulations in the clutch plates assist, and thirdly, the springs interposed between the engine and the driving component of the torque converter play their part.

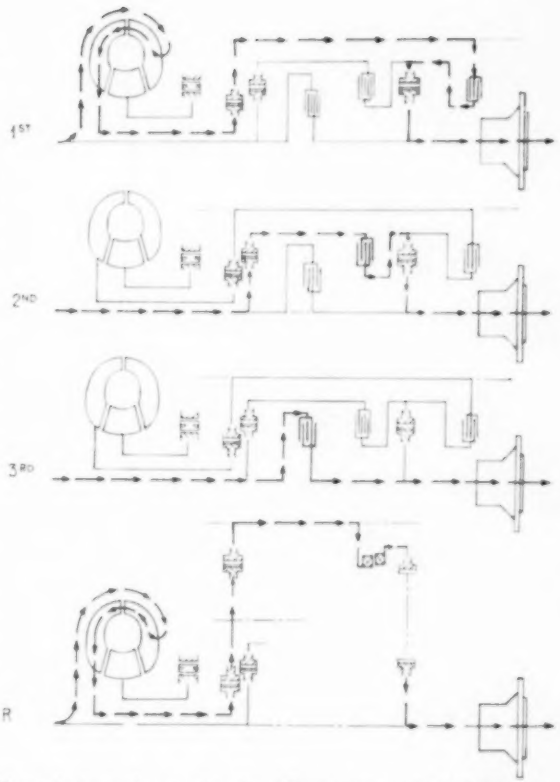
Hydraulic system

The oil used for the hydraulic system, including the torque converter, is the same as that used to lubricate the gearbox, and both systems drain to a common sump. Two gear type hydraulic pumps, fitted with intake screens and having magnetic filter plugs, are employed. They are on a common shaft mounted parallel to that of the reverse gear assembly, in the base of the gearbox.

The larger of the two pumps is for supplying the torque converter. Its delivery pressure is limited to 30 lb/in^2 by a relief valve, the overflow from which is directed to lubricate some of the mechanical components in the gearbox. This pressure is adequate to prevent aeration of the oil in the converter, but not so high as to be difficult in respect of sealing. The smaller pump serves the gear-change system. From it the oil first passes through a multi-leaf type micro-filter. Thence it goes to a distributor valve assembly, from which it is directed to the pressure regulator valves and the clutches. A relief valve in this system restricts the pressure to 110 lb/in^2. The excess oil from this relief valve is fed into the converter circuit.

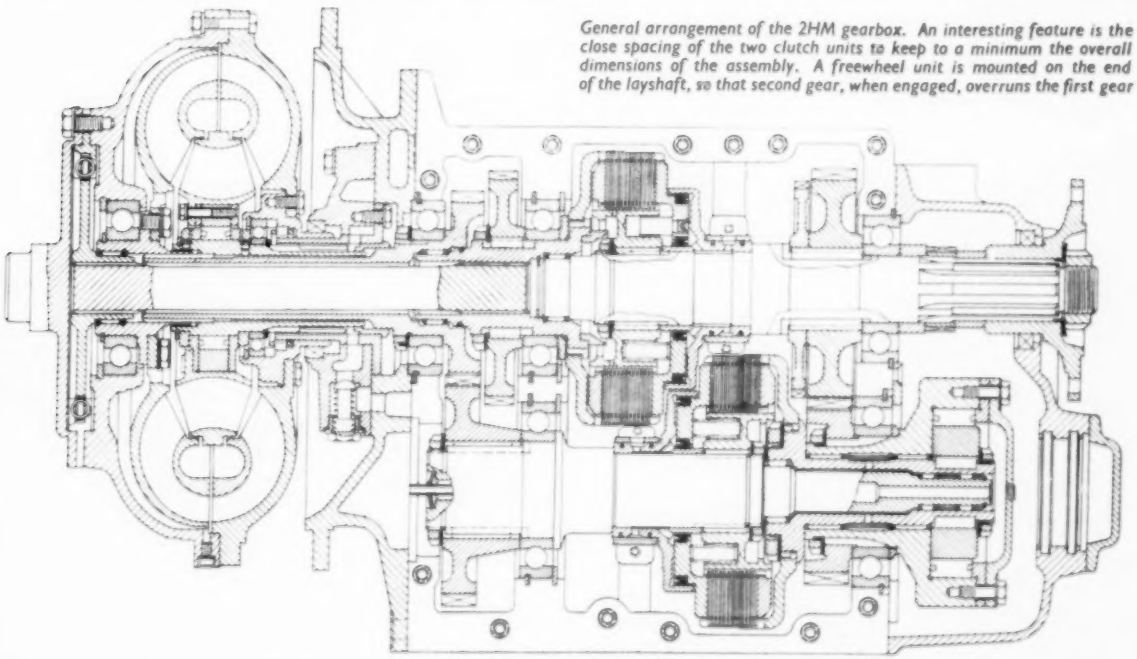
Although the pressure of 110 lb/in^2 is adequate for second, third and reverse gear operation, it is not regarded as high enough for first gear in either of the two-speed units or in the three-speed version. Therefore, a pressure regulating valve, operating on the differential piston principle, is incorporated in the circuit for operation of the first speed clutch, to boost this pressure to 140 lb/in^2.

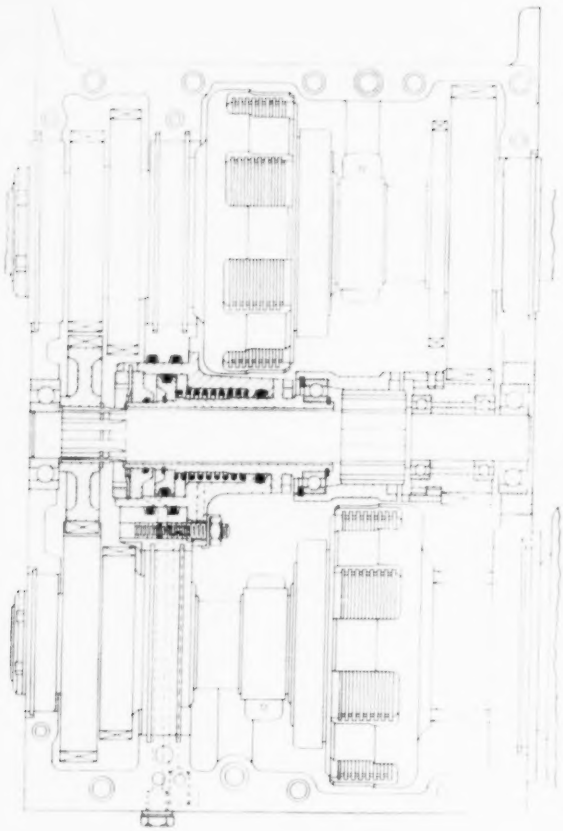
Since the oil temperature is liable to rise fairly rapidly under certain conditions in the torque converter, the outlet from this unit is taken through an oil cooler. When the transmission is used with water-cooled engines, this cooler is of the oil-to-water type, and is bolted directly to the gearbox. With air-cooled engines, however, the converter outlet is connected by pipes to an air-cooled heat exchanger,

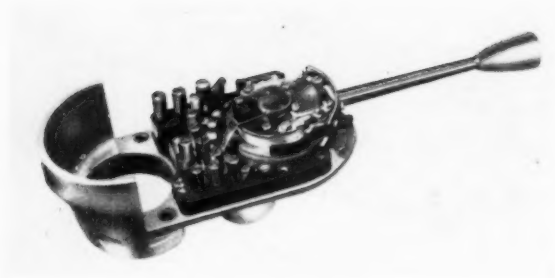


Transmission paths, to give the different gears, in the 3HM units

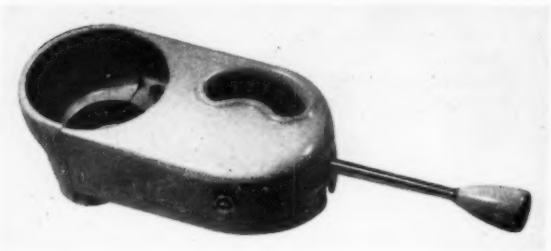
General arrangement of the 2HM gearbox. An interesting feature is the close spacing of the two clutch units to keep to a minimum the overall dimensions of the assembly. A freewheel unit is mounted on the end of the layshaft, so that second gear, when engaged, overruns the first gear





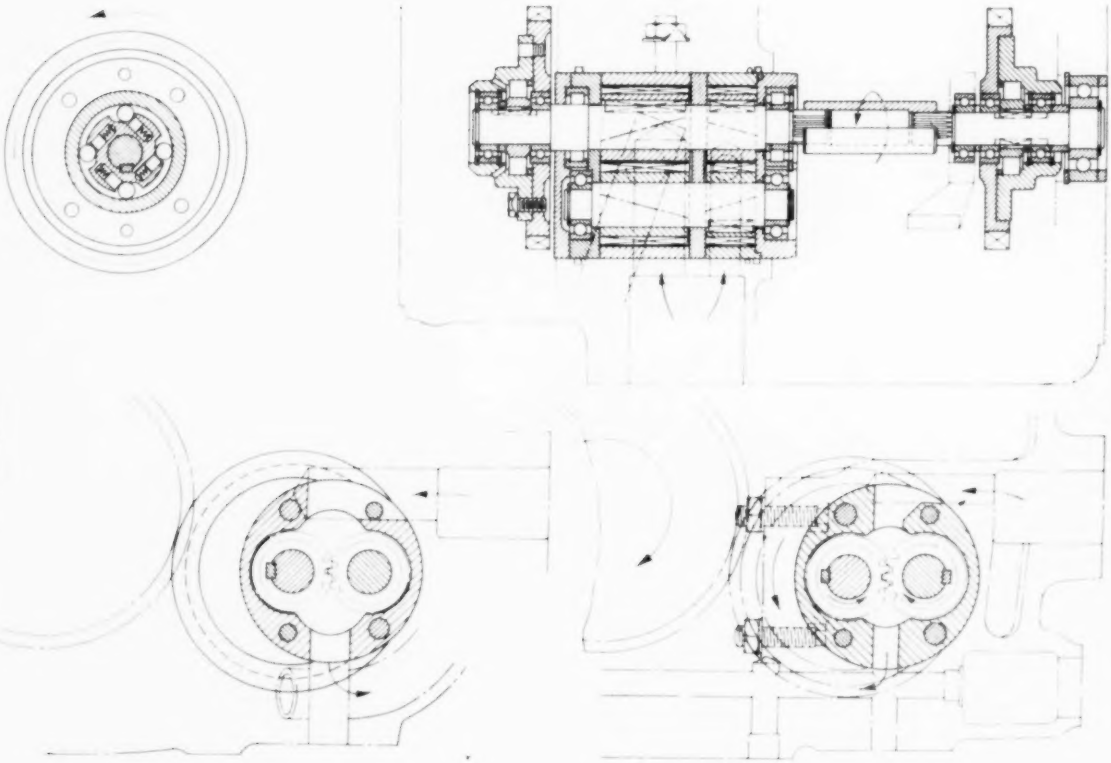


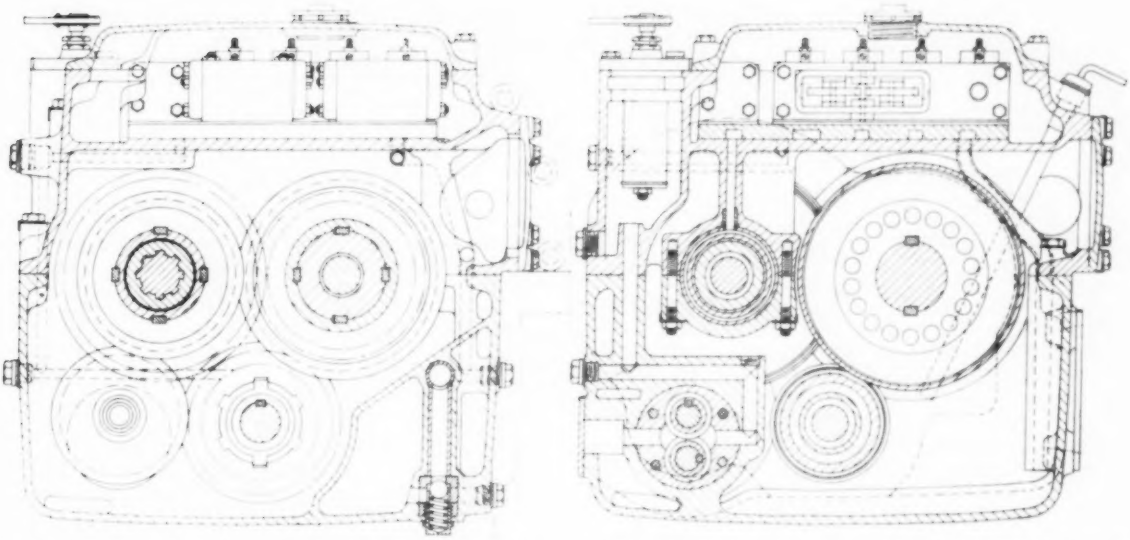
Control switch unit; below, complete and, above, with the cover removed



The illustration on the left shows a cross section through the reverse gear dog-clutch and its hydraulic actuating mechanism on the 3HM-40

Below are the details of the oil pumps for the torque converter and control system, and their drive gears and roller type freewheel units





Cross sections of the 3HM-50 gearbox, with the layshaft on the left and the mainshaft on the right, above the pump and reverse idler shafts respectively

and thence back to the gearbox sump. In all installations, a warning lamp on the dash is illuminated if the oil temperature reaches 230 deg F. In this event, which, incidentally, should not occur under normal conditions, the method of driving should be modified or the vehicle should be stopped to allow the oil to cool.

To drive the pumps there are two gears, one at each end of the shaft. Both gears are mounted on freewheel units of the roller type. The smaller of the two meshes with the gear on the input shaft, while the larger one is driven by a gear on the output shaft. Therefore, so long as the engine is running, the drive is taken from the input shaft, the other gear freewheeling. This second gear comes into operation if the engine is stopped, and is used, for example, when the vehicle is tow-started.

Electrical system

The electrical system controls four solenoids, which are individually secured by set screws to the hydraulic distributor valve unit, and are readily accessible when the top cover of the gearbox is removed. They can be supplied for use with either 12-volt or 24-volt systems. The connection for the electrical leads on the outside of the gearbox is an oil-tight multi-pin plug.

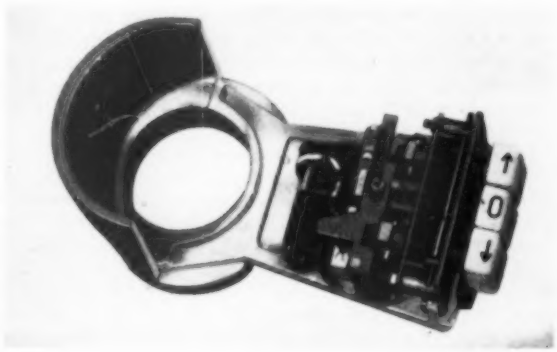
The selector, which is mounted on the steering column, is basically a distributor switch and incorporates a mechanical indicator to show which gear has been selected. This switch is actuated by a manually operated lever and pawl-and-ratchet mechanism, similar in principle to that used in many motor cycle gearboxes; upward changes are effected by upward movements of the lever, and downward changes by movements in the opposite direction. If it is required to select a gear which is separated from the one already in engagement by more than one ratio, the lever must be moved the appropriate number of times. Thus, it is possible to change into neutral from any of the gears, provided the engine speed is not too high.

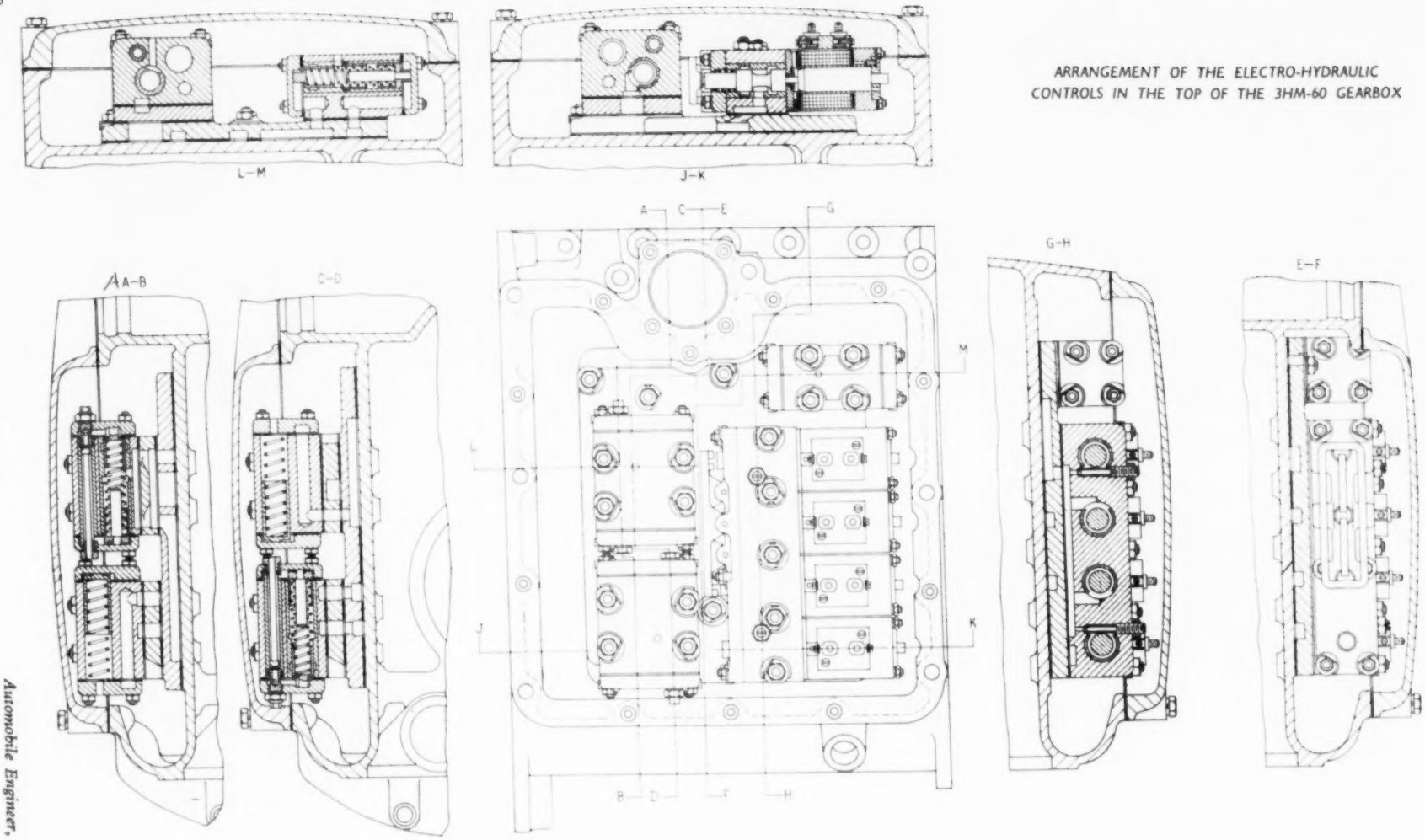
The lever actuates a contact in such a way that each time it is moved to select a gear, this contact opens and breaks a circuit through the second- and third-speed solenoids to earth. Thus, the solenoids are not energized, to actuate a hydraulic control, until the lever is returned by its centralizing springs. This arrangement has been adopted so that the driver can pause, if necessary, during the change, to adjust the engine speed to suit the gear selected. However, this is only desirable when the vehicle is started with the transmission cold; in the Hydromedia three-speed gearboxes, the smoothness and rate of gear change are automatically regulated so that intervention by the driver under normal operating conditions is not required.

A small solenoid is incorporated in the switch used with the three-speed boxes, to prevent downward changes when the engine speed is too high. When this solenoid is energized, it moves a locking peg into engagement with the pawl carrier at the root-end of the control lever. Energization of the solenoid is effected by the closing of a switch operated by a centrifugal governor. This governor is mounted on the rear end of the layshaft.

Before reverse gear can be engaged, the vehicle must be stationary and a locking button must be operated and held in the depressed position. With the 3HM gearboxes, the selector lever is first moved to an intermediate position, which must be held for two or three seconds, and then the lever can be moved into the reverse position. In the intermediate position, the switch energizes both the first-speed and the reverse solenoids. The reason for this is as follows. When the engine is idling and the transmission in neutral, the hydraulic forces in the coupling, although inadequate

Push button control for the fully automatic system. The arrows and the O indicate the buttons for forward, reverse and neutral, the reverse being used in conjunction with a release button, not visible here



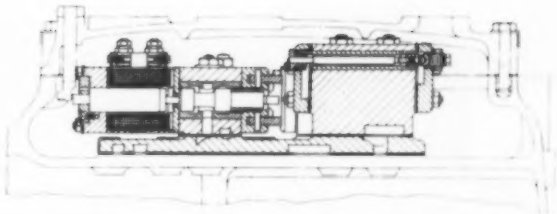


ARRANGEMENT OF THE ELECTRO-HYDRAULIC CONTROLS IN THE TOP OF THE 3HM-60 GEARBOX

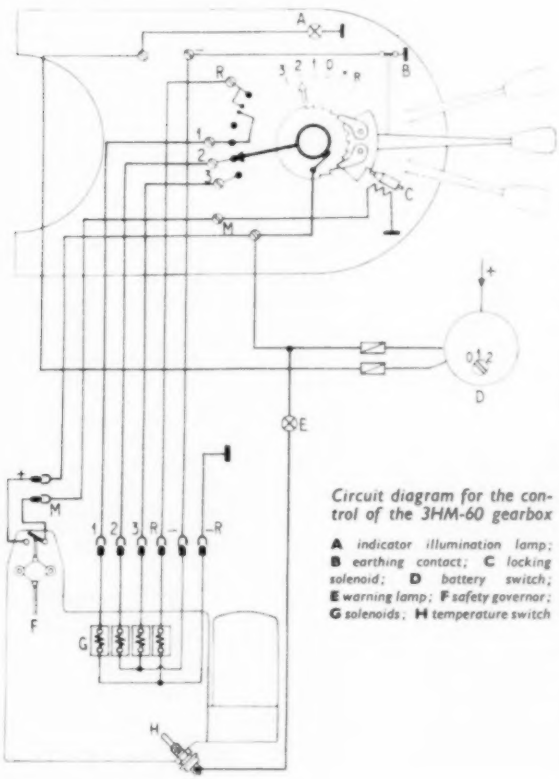
In the plan view, the relief valve is in the top right-hand corner, the solenoids and control valves are below it, with the two pressure regulating valves to the left of them

to drive the vehicle, are enough to spin the turbine member in its free state. Since this member is connected to the first-speed gear, which is in constant mesh with the reverse idler, these components are all spinning together, and it would therefore be impossible to engage the reverse gear dog clutch. Thus, the engagement of the first-speed multi-disc clutch, which connects the turbine rotor to the stationary output shaft, stops the rotor and the reverse idler from spinning. If, in this condition, the engine speed were inadvertently increased to the point where a positive drive were transmitted through the first-speed gear train, the two components of the reverse speed clutch would rotate in opposite directions, and therefore engagement of the clutch would still be impossible. When the correct procedure for reverse gear selection is followed, the reverse clutch can be engaged as soon as the turbine rotor stops spinning. This condition can be obtained more rapidly, if necessary, by momentarily raising the engine speed, to increase the output from the hydraulic pump serving the first and reverse gear clutches. With the 2HM gearboxes, the intermediate operation of the first-speed clutch is effected automatically by a change-over valve in the hydraulic system.

In the event of a failure of the electrical system, the gears can be selected manually, but not from the driver's seat. To perform this operation, the lock-nuts of a set of screws on the cover of the gearbox have to be loosened, so that the valves can be actuated by using a screwdriver to turn the appropriate screw 180 deg. The slots in these screws must always be in a transverse direction relative to the axis of the transmission, and a red dot on the end face of the screw indicates whether the gear is engaged or disengaged: when the gear is engaged, the red dot is nearest to the engine. The gear that each screw controls is indicated by an embossed figure adjacent to it on the cover. These screws simply actuate the appropriate hydraulic valves. If the driver is operating the vehicle alone, and such an emergency arises, he can only return the vehicle in first gear to the depot. However, if he has an assistant, it is possible for the gears to be shifted while the vehicle is being driven back for the appropriate repairs to be effected.



The vertical screw and lock nut, shown chain-dotted in the top left-hand corner of this section, are for emergency manual control of the valve



Circuit diagram for the control of the 3HM-60 gearbox

A *indicator illumination lamp;* **B** *earthing contact;* **C** *locking solenoid;* **D** *battery switch;* **E** *warning lamp;* **F** *safety governor;* **G** *solenoids;* **H** *temperature switch*

Detail arrangements

The two components of the transmission, that is the torque converter and the mechanical gearbox, are each enclosed by heat-treated Siluminium castings. Of these, the gearbox casing assembly is, of course, the largest, and its main component is the central one, in which the gears and first, second and reverse clutches are housed. This main casting is divided on the plane containing the axes of the main shaft and layshaft, and its two pieces are located relative to each other by two dowels in diagonally opposite corners.

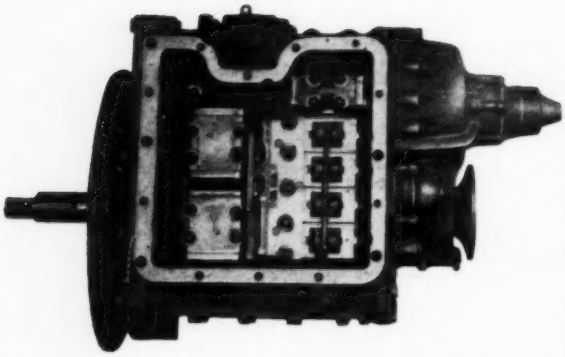
Nineteen bolts secure the halves of the casing. Of these, all except the three along the rear edge of the box are 10 mm diameter; the three exceptions are 12 mm diameter. The arrangement of those at the rear end of the box is as follows: one bolt passes vertically through both parts of the casting, between the housings for the main and layshaft bearings, and the other two are similarly arranged one on each side of these bearings. At the front end, the geometrical arrangement is the same. The other bolts are distributed more or less uniformly along each side of the box. All the bolts are readily accessible, and the division of the box on the plane of the axes of the shafts facilitates both assembly and maintenance. In addition, the retaining bolts secure a separate cover on top of the unit and, when this is removed, access can be gained to the valves and solenoids of the electro-hydraulic control.

Another casting is bolted to the rear end of this housing. In it are the speedometer gear and, in the case of the 2HM gearboxes, the substantial freewheel unit for first speed; in the 3HM gearboxes, the first speed clutch is substituted for the freewheel, and the governor housing is spigoted to the rear face of the casting, and driven by the tail end of the layshaft.

The front end of the gearbox is closed by a cover, which forms part of the bell housing for the torque converter. Yet another casting is bolted to the front face of this cover: in the 2HM boxes this houses the relief valve for the oil supply to the torque converter and also embodies the ducts for the supply of oil both to and from the converter; in the large units in the 3HM series of gearboxes this cover houses the freewheel unit for the stator of the torque converter.

It is of interest to note that the overall length of the gearbox casing of the 2HM units is approximately 12$\frac{11}{16}$ in, while that of the 3HM gearboxes is only about $\frac{7}{8}$ in longer. The overall length of the assembly, including the front and rear cover, but excluding the housing for the governor, is approximately 21 in for the 2HM gearboxes and 23 in for the 3HM units. Over the central portion of the gearbox casing, the width is about 14$\frac{7}{8}$ in for the 2HM units and 16$\frac{11}{16}$ in for the 3HM units.

As can be seen from the accompanying illustrations, the arrangements of the mechanical components of the two



boxes are similar. The main differences are the additional clutch and indirect gear pair, and absence of a freewheel in the 3HM unit. In the case of the 2HM-60 and 3HM-60 units, the layshaft is on the left-hand side of the box, while in the 70 series it is on the right. The manufacturers state that no difficulties have been experienced with regard to the reaction of axial thrust through the roller bearings. In this connection, the thrust and reaction of the clutches, of course, balance each other out, so the only thrust taken by the bearings is that due to the helical arrangement of the gear teeth. Since there are two clutches on the layshaft of the 3HM units, one is splined directly to the rear end of the shaft, and the other is mounted on a sleeve assembly between the two ends. All the sleeves and floating gears are carried on needle roller bearings.

Lubrication of all the gears and bearings is effected by splash. Special arrangements are made, however, for the supply of oil to the freewheel at the rear end of the layshaft in the 2HM gearboxes. The overflow from the relief valve in the oil supply to the torque converter is passed into a chamber cored in the rear face of the front cover. This chamber is closed by a disc retained, by the front cover, in a counterbore round the aperture in the front wall of the gearbox, immediately in front of the layshaft. A stack pipe, carried in a hole in the centre of this disc, projects into an axial hole in the layshaft; the oil passes into this hole and is prevented from running directly out again at the front end by a dished washer pressed in a counterbore in the end of the shaft, so that it surrounds the stack pipe. Thus, the oil flows to the rear end of the shaft and out into the freewheel unit, whence it then drains back again to the sump.

All the other details of the gearbox are apparent in the illustration, and the transmission paths are shown in the accompanying diagrams. In the 2HM gearboxes, when second-speed is selected, the first-speed clutch remains in engagement but, of course, is overridden by virtue of the freewheel in the first-speed train. The speed ranges in the various gears are shown in the curves, and the ratios are given in the accompanying table.

Torque converter

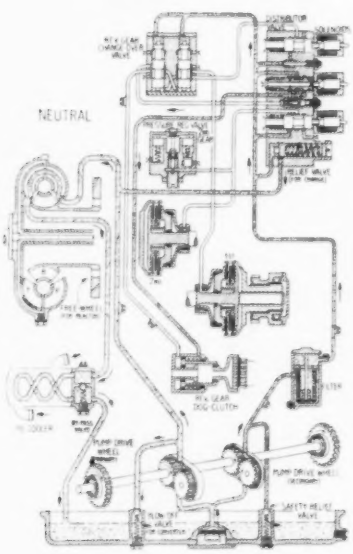
In the small units in the 2HM series, the stator of the torque converter is mounted directly on the freewheel. This arrangement is compact and adequate for the torques that the unit is likely to be called upon to transmit. The centre component of the freewheel is carried on a sleeve splined into a sleeve extension of the casting that houses the pressure relief valve, which, as has already been mentioned, is bolted to the front cover of the gearbox. This sleeve extension is flanged at its rear end, and it is passed from the rear through a large diameter hole in the casting, to which the flange is secured by setbolts. The outer periphery of the flange registers in a counterbore in the front cover, to locate the whole assembly relative to the axis of the mainshaft.

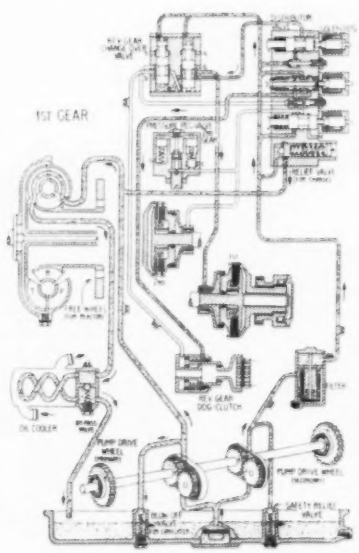
The front end of the sleeve extension forms the inner race of a roller bearing, the outer race of which is formed by a central component of the rear half of the pump member of the torque converter. Thus, the roller bearing supports the rear end of the pump, the front end of which is spigoted into the crankshaft. An oil seal bears on a rearward extension of the central component already mentioned, and a ball bearing is housed in a forward extension of this component. The ball bearing carries the central component of the stator. A large ball bearing, housed in the front half of the pump casing, carries the turbine rotor assembly.

As has already been mentioned, fluid is supplied to the torque converter at a pressure of 30 lb/in^2. In the 2HM units, it passes from the relief valve, forward along the splines between the sleeve extension of the relief valve housing and the freewheel carrier. Thence it goes through the ball bearing and enters the torque converter between the stator and pump members. After passing through the torque converter, it leaves the unit between the turbine member and the stator, and then goes through the clearance

The half-tone illustration at the top of this page is of the ZF 3HM gearbox, with the cover removed to disclose the controls

On the right are five diagrams showing the functioning of the different components of the control system of the 2HM gearbox when neutral, first gear, second gear, intermediate position for reverse, or reverse gear are selected





between the freewheel carrier and the outer periphery of the tubular shaft of the primary gear—as can be seen from the illustration, the turbine member is splined on to the front end of this tubular shaft. Finally, the oil passes through the ball bearing that carries the primary gear, and then drains down to the sump.

In principle, the arrangement of the bearings for the torque converters of the 3HM gearboxes is similar, except for the fact that there are two ball bearings instead of one supporting the stator. One of these two is mounted on a sleeve splined into the centre component of the freewheel, while the other is interposed between this sleeve and the rearward extension of the central portion of the front half of the pump, where it is splined on to the tubular shaft of the primary gear. Because of the magnitude of the torque that it has to transmit, the freewheel is too large in diameter to be carried in the centre of the stator, so it is housed in the front cover of the gearbox.

Hydraulic control

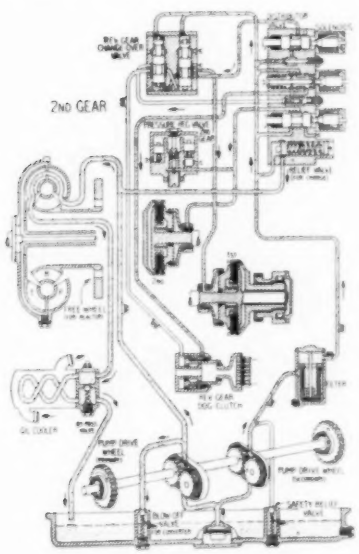
The accompanying diagrams of the hydraulic controls show the principle of operation of the system. Oil passes from the gear type pump through the filter to the hydraulic distributor valve. When one of the solenoids mounted on this valve assembly is energized, it actuates one of the valves, to allow the oil to flow to the appropriate clutch. In each case, the oil is delivered to a sleeve round an extension of the clutch actuating cylinder. After passing through the connection to this sleeve, it goes into an annular groove round the periphery of the extension of the cylinder. Two piston-ring type seals, one on each side of the groove, prevent the oil from escaping along the extension. Radial holes are drilled through the base of the annular groove to allow the oil to enter another annular groove, which is machined in the bore of the sleeve, except in the case of the second-speed clutch of the 2HM series, in which this groove is machined in the output shaft. In each case the oil then passes through a hole drilled into the hydraulic cylinder.

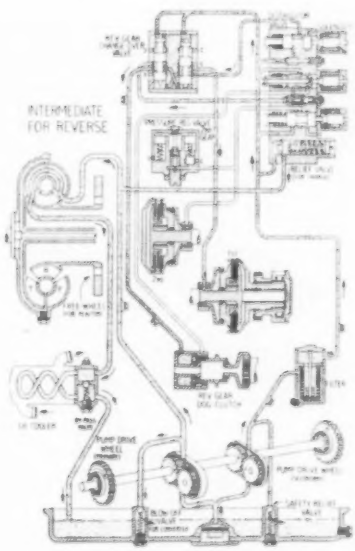
In detail, the control of the 2HM gearboxes operates as follows. With the control in the neutral position, the oil is fed under pressure to all the valves, but it cannot go any further from those that are closed. In the case of the reverse valve, however, the porting is arranged so that the oil can flow through the valve to the dog clutch actuating cylinder, to assist the return spring in holding the reverse gear clutch out of engagement. Oil is also supplied under pressure to the change-over valve for reverse gear, but this valve does not come into operation until reverse gear is selected. The overflow from the relief valve passes into the circuit to the torque converter.

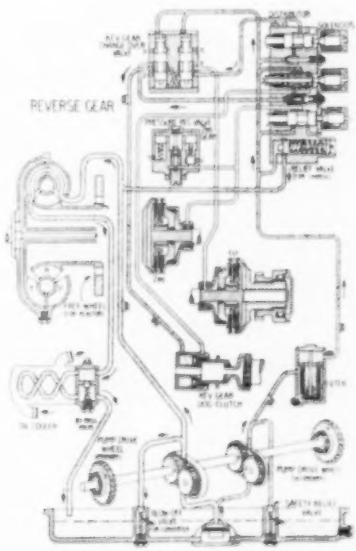
When first gear is selected by the driver, the solenoid for the first-speed gear depresses the first-speed valve, against its return spring, in the hydraulic distributor unit. This moves the valve into a position such that oil can flow through it. The route followed by the oil is as follows: it goes past a conical-ended restrictor screw, by means of which the rate of engagement of the first-speed gear clutch can be adjusted, then through the valve and into the change-over valve for reverse gear. One slide of this valve is in a position such that the oil can pass from it directly to the first-speed clutch, which it therefore engages. At the same time, the oil pressure forces the other slide upwards: the movement of this slide is not necessary for the engagement of first-speed but, as will be explained later, it is an essential preliminary for the engagement of reverse.

As soon as the second-speed is selected, the valve that controls the operation of the second-speed clutch opens, allowing the oil to pass through to the clutch and the regulator valve. This valve restricts the pressure initially to 40 lb/in^2 and, after a slight delay, allows it to come up to its full value of 110 lb/in^2. The way in which the valve operates is as follows: oil entering it passes a relief valve, which is set to blow-off at the lower pressure. While this is occurring, the oil is passing a conical-ended restrictor screw into a chamber above the relief valve. At first it depresses a spring-loaded piston in an accumulator; then when the accumulator is filled with oil, the pressure begins to increase and forces down another piston, which increases the load in the spring that controls the blow-off valve and in this way raises the pressure in the pipeline to the clutch. The first-speed clutch is still in engagement, but the first-speed gear is inoperative because of the action of its free-wheel.

When the control lever is moved for the selection of reverse gear, the first-speed clutch is engaged in the manner already described. At the same time, the oil circuit to the reverse clutch is brought into operation in the following way. The solenoid opens the reverse gear hydraulic valve, and allows the oil through it and past a restrictor, set to give a slower rate of flow than that for the first gear, and thence it goes to the second slide of the change-over valve.

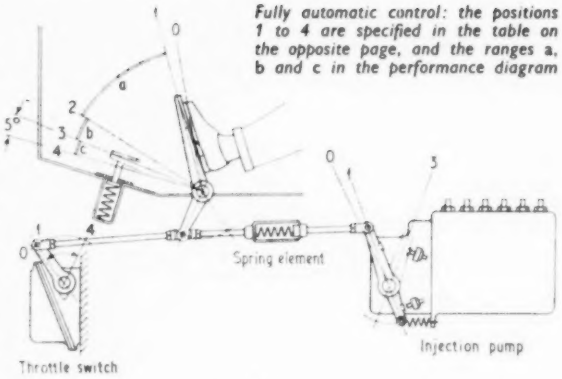




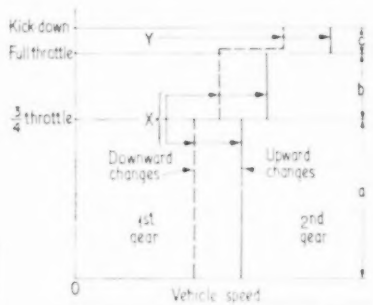


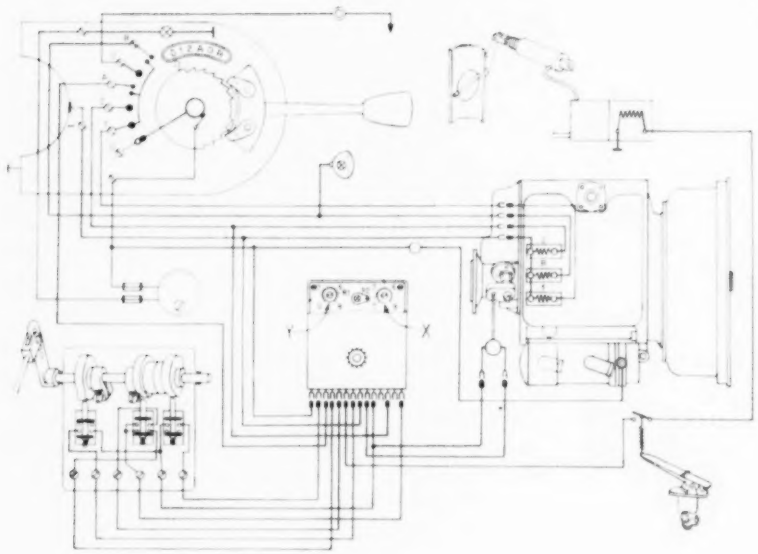
The pressure is transmitted from the annular space round this slide to the base of the first slide, which it lifts and thus cuts off the supply to the first-speed clutch. When the movement of this slide is complete, the pressure increases in the supply to the hydraulic actuation mechanism of the reverse speed clutch, which is therefore moved into engagement. When the oil pressure in this unit reaches approximately 70 lb/in^2, the first-speed clutch is released. Incidentally, the restrictor in the supply from the selector valve to the second slide in the change-over valve incorporates a non-return ball valve installed in such a way that the restrictor is by-passed when the oil returns during the disengagement of the clutch.

The control system for the 3HM gearboxes is slightly different. In the neutral condition, the oil pressure is taken to the distributor valve, while the overflow from the relief valve goes to the converter, as in the 2HM units, but it does not go to any of the other valves or cluches. When first gear is selected, the solenoid opens the first gear valve. This allows oil to flow in two directions: one is to the pressure



Fully automatic control: the positions 1 to 4 are specified in the table on the opposite page, and the ranges a, b and c in the performance diagram

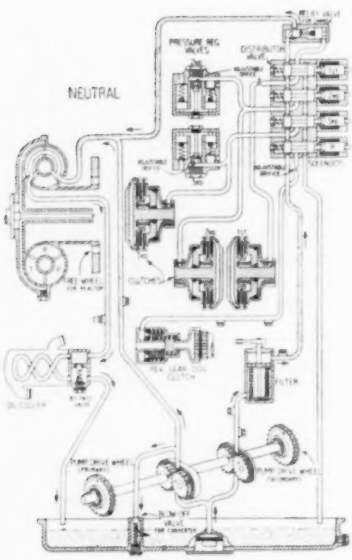


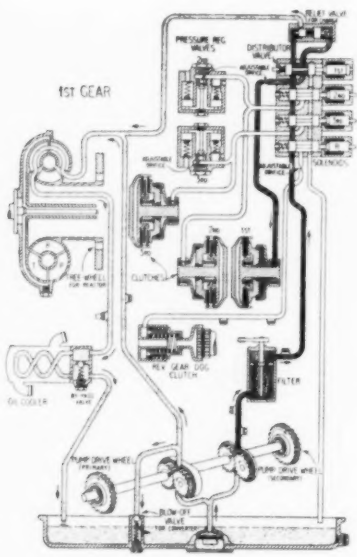


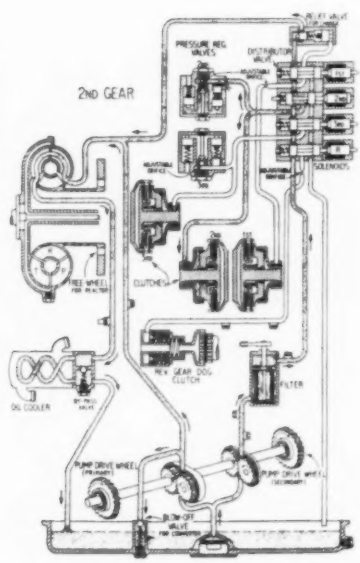
The positions of the gear-change points X and Y on the above performance diagram can be adjusted by the potentiometers X and Y shown in the electric circuit diagram, on the left, for the fully automatic control system. The components of this system are depicted in the half-tone illustration in the top right-hand corner of the opposite page. The key for the latter illustration is:

Items marked 1 are various arrangements of push-button and lever type controls; 2 automatic control box; 3 generator for the speed signal; 4 its adapter; 5 the transmission; 6 control for the injection pump; 7 throttle switch, for the torque signal; 8 the spring stop of the kick-down system for retaining indirect gear for acceleration

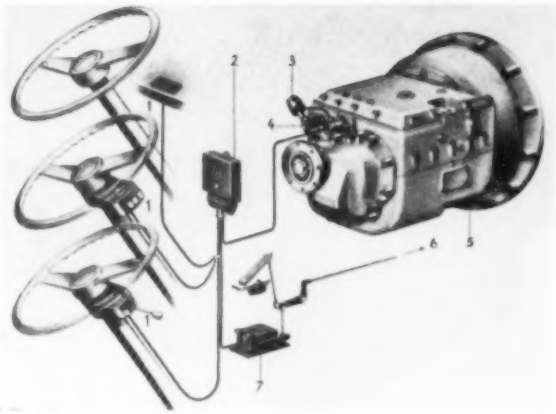
The diagrams below show the functioning of the 3HM electro-hydraulic system







Accelerator position	Injection pump control position	Accelerator pedal spring-stop	Spring element in linkage	Throttle switch	
				Single cam switch	Double cam switch
0 released	stop	—	—	closed	open
1 vehicle at rest	slow running	—	—	closed	open
2 part throttle	from about ¾ to full delivery	—	—	open	open
3 full throttle	on the full delivery stop	pedal on the spring-stop; spring reaction giving about 150 cm-kg torque measured about the throttle pivot	—	open	open
4 kick-down	—	spring-stop compressed; torque reaction about pedal pivot 250 cm-kg	spring compressed	open	closed



relief valve, where it acts on a piston to compress the relief valve spring, to increase the blow-off pressure from 110 lb/in^2 to 140 lb/in^2—as has already been mentioned, this is necessary for the transmission of first gear torque—in the other direction, the oil passes through a restrictor orifice to the first-speed clutch. The restrictor is adjustable to regulate the rate of engagement of the clutch.

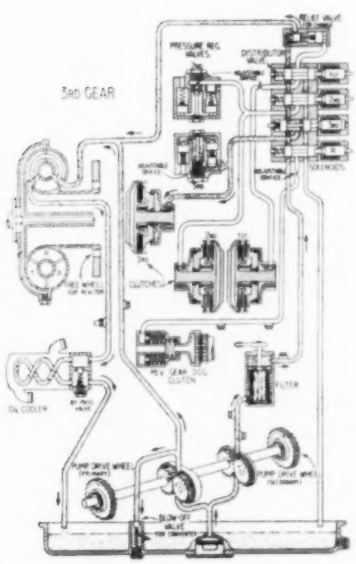
When the second gear is selected, the first-speed valve closes and the second-speed valve opens, each under the influence of its solenoid. Thus, the pressure in the first-speed control system is released and the relief valve returns to give the normal pressure of 110 lb/in^2. At the same time, the oil is directed towards the second-speed clutch, but its pressure builds up gradually because of the action of the pressure regulator valve connected to this circuit. The principle of operation of this pressure regulator valve is exactly the same as that already described in connection with the 2HM gearboxes. Third-speed gear control is effected in a similar manner.

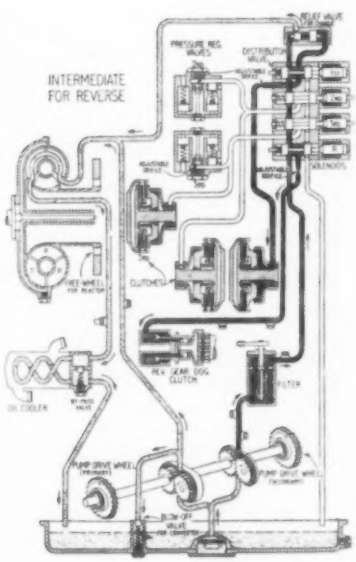
In the outlet from the reverse speed solenoid to the dog clutch, there is an adjustable restrictor because, like that for the first-speed clutch, this circuit does not incorporate a pressure regulator valve. As has been mentioned in the section dealing with the mechanical components of the gearbox, except in the 3HM-60 unit, the reverse gear dog clutch is engaged and disengaged by hydraulic pressure, but with spring assistance for disengagement. Another difference between this and the 2HM system is that, in the 3HM system, there is no change-over valve for reverse gear selection. Instead, the gearshift lever has to be moved to an intermediate position, in which the electric circuits to both the first and reverse speed solenoids are completed, so that the two clutches are engaged simultaneously. When the lever is moved again, to complete the change into reverse gear, the circuit to the first-speed solenoid is broken and, therefore, that clutch is released.

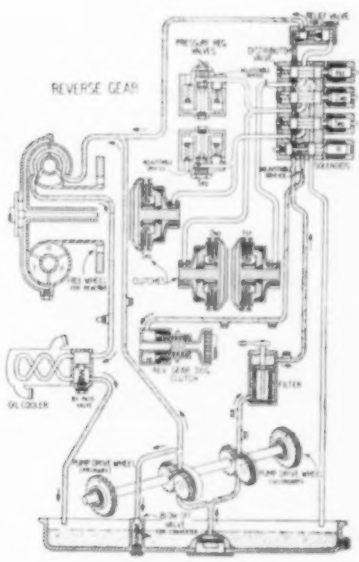
Automatic control

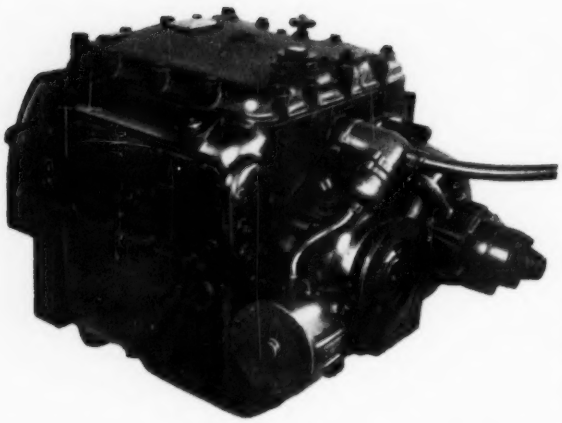
The principle of operation of the automatic control, which is of ZF design, is similar to that which has been offered in Great Britain for application to Wilson type gearboxes. Basically, the control system comprises a small generator driven by the output shaft of the gearbox, a three-stage switch connected to the throttle pedal, and the automatic control box. The function of the generator is, of course, to provide a signal proportional to vehicle speed, while that of the three-stage switch is to give a signal proportional to the torque requirement.

A noteworthy feature of the system is the fact that the automatic control box is transistorized and, therefore, is









This illustration shows the rear end of a gearbox equipped for fully automatic control. The extra components are installed in such a way that they make little difference to the overall dimensions of the unit

very compact; in fact, it is so small that it can be carried in the pocket. In the event of a fault developing in the control box during service, it is recommended that the box be removed and a new or reconditioned one fitted in its place. This is a simple matter, not only because of the small size and light weight of the unit, but also because all the electrical connections are made through a single multi-pin plug, and the control box is secured to the vehicle by only two screws.

The control is arranged so that either first or second-speed can be held or the transmission operated automatically. It is of interest to note that the gear selector positions are 0, 1, 2, A, 0 and R. The two neutral positions are necessary in order that a start from neutral can be made either progressively through first- and second-speeds or from the other neutral position directly into automatic or reverse gear operation. From the circuit diagram, the basic principle of operation of the system can be seen, and the diagram showing the relationship between vehicle speed and throttle opening shows the gearshift characteristics obtained. Downward gearshifts, of course, are effected at a lower speed than the upward ones, to prevent hunting.

Heat and Vapour Sealing Process

INFORMATION has been received from the Metal Finishing Division of the Pyrene Co. Ltd. regarding a new treatment that provides a protective chemical blanket for hot immersion processing baths. The treatment is known as Heat-Lok; its purpose is to reduce heating costs and maintenance of the equipment, and to improve working conditions. There are two components: the sealant, to form a protective blanket on the surface of the bath, and the additive, which is a surface activating agent and is added to the processing solution in the bath.

Heat-Lok has no harmful effect on the coating characteristics of the solution. In fact, according to the manufacturers, it frequently increases the process efficiency by tending to produce more complete and uniform coatings. After the initial application of the treatment to the bath, the additive is replenished in direct proportion to the amount of chemical added to maintain the correct concentration of the solution. The sealant is added, as required, to maintain the thickness of the surface blanket at about $\frac{1}{2}$ in.

It is claimed that the use of Heat-Lok saves up to 70 per cent of heating costs, by virtually eliminating surface evaporation; the sealing effect also greatly reduces warm-up time. Since vapour, fumes and heat do not pass the blanket, the working conditions in the shop are considerably improved. Heating elements require less frequent attention, because of the reduction in the heat consumption. Requirements for exhausting fumes are minimized or even eliminated. A further advantage is that the blanketing of corrosive vapours reduces deterioration of nearby equipment.

Welding Design Advisory Service

OBVIOUSLY, the fullest possible advantage of welding as a method of construction can be obtained only if the design has been laid down having due regard for technical requirements in respect of the making and functioning of this type of joint. In the past, some engineers have formed an adverse opinion of welding for certain applications, not because of any real defects of this system as a method of joining components, but because the designs were unsuitable and failures therefore occurred.

The British Welding Research Association, of Abington, Cambridge, is now offering a design advisory service. They have, of course, had long experience of this subject in almost every field of application. The services they offer include the fatigue testing of models or prototypes and the stress anaylsis of structures on site. In addition, they will be able to contribute, from their very wide field of experience, to ensure that layouts are such that welds are disposed most advantageously, and that the size, type and location of welds are suitable for the loads that will be imposed upon them. Where the loads are not known sufficiently accurately, mobile strain-measuring equipment is available for the determination of the loads in prototype and other structures under actual service conditions. This service should be of considerable help to industry, because welding is a subject that calls for the application of highly specialized knowledge, which is available in the British Welding Research Association's establishment at Abington Hall, Cambridgeshire.

Better Chromium Plating

A NEED for improvement in the durability of some chromium plating has long been apparent, and a new British Standard has been introduced with this aim in view. It is entitled "Electroplated Coatings of Nickel and Chromium", and carries the number B.S. 1224:1959. This standard is a revision of an earlier specification, the main difference being in the provision for a thicker coating of nickel. It is, of course, this coating rather than the external flash of chromium that governs the quality of the finish. Now that nickel is no longer in short supply, the B.S.I. considers that adequate coatings are now practicable.

Another change in the specification is the inclusion of new and more stringent laboratory tests, which plated products must pass if compliance with the standard is to be claimed for them. Two of these tests are intended to ensure that plating will withstand corrosive conditions, for example, those encountered by external fittings such as bumpers on cars.

The non-destructive testing of plating is now facilitated by an instrument developed by the British Non-Ferrous Metals Research Association. It can be used for the accurate gauging of the thickness of the nickel coating, and attention is drawn in B.S. 1224 to its value for quality control. Copies of the new standard can be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. The price is 5s, postage extra to non-subscribers.

Filing Drawings and Other Documents

By a combination of three established techniques it is now possible to reduce the demands on drawing office accommodation for filing documents, including engineering drawings, and at the same time to increase the speed of selection and issue of documents required. The three techniques are interdependent: compact filing facilities are provided by microfilming all records and drawings; rapid selection of documents for issue is effected automatically by the employment of punched cards; finally, full-size copies of these documents are produced rapidly by xerographic printing.

A SYSTEM by which considerable savings can be effected in respect of both time and storage space, for the handling of documents, has been described in the October-December 1959 issue of our associated journal *Data Processing*. The value of such an arrangement will be readily appreciated by all who have had experience of the complex systems employed in some sections of industry. With the arrangement described, documents, including engineering drawings, are microfilmed; each individual picture is cut off the roll of film and mounted over an aperture cut in a standard 80-column punched card; then, data identifying the record are punched in the columns. When the document is required to be reproduced, the appropriate card is selected either manually or automatically from the file. It is then placed in a projector mounted on a Copyflo xerographic printer, and the required number of reproductions is printed automatically at a speed of 20 ft/min. Obviously, other methods of mounting the microfilms can be employed: for example, edge-punched cards can be used.

Perhaps the greatest advantage of this system is the saving in office space: floor space of about 2,000 ft^2 is required to house a library of 600,000 full-scale drawings, but if these drawings are recorded on microfilm this can be reduced to approximately 50 ft^2. Not only can the operations necessary for the filing and reproduction be effected automatically, where the numbers handled justify the employment of relatively complex machines, but also, for the handling of smaller numbers, where some of the operations are effected manually, it is much easier and quicker to pick out one of the cards and place it in the magazine of the Copyflo machine than to select a full-size tracing and feed it through a dyeline printing machine. Since the cost of reproduction is low, the prints can be discarded after use. Provided the drawings are clearly executed with firm lines and letters, tracing is unnecessary.

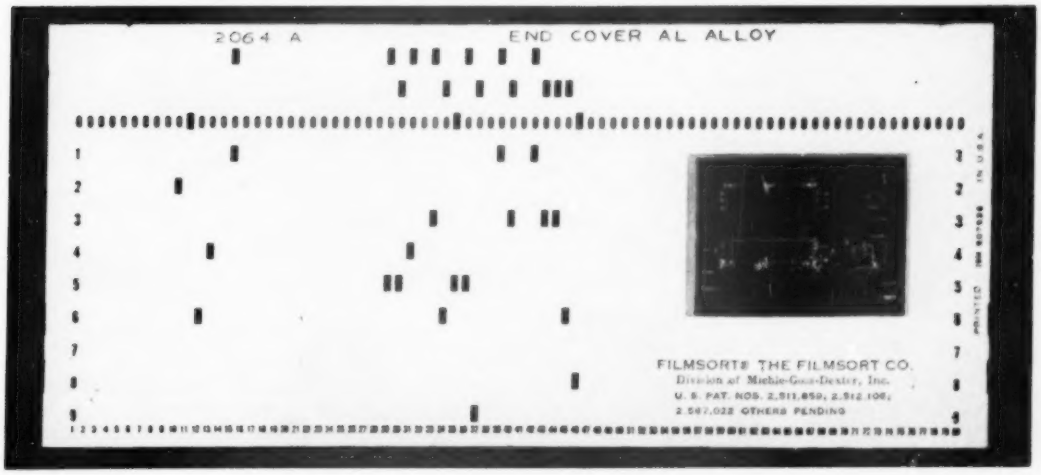
With the exception of machines for mounting the microfilms on cards, which are imported from the United States, all the equipment is built in Great Britain by Recordak Division of Kodak Ltd. and Rank XeroX Ltd. Kodak manufacture the microfilming equipment and the other firm produce the Copyflo printers.

Obviously, if this method of filing and reproducing engineering drawings were to be adopted universally, it would be advantageous to have a standardized system, so that cards can be interchanged freely between manufacturers, and passed on, perhaps in the form of complete libraries, to sub-contractors or licensees. In view of the small space occupied by these cards, they can be conveniently despatched through the post. Drawings and other documents measuring 30 × 40 in can be recorded on a 35 mm microfilm.

Mounting the film

Several machines of varying complexity are available for mounting microfilm on the cards. The simplest of these is a small manually operated portable unit. It is used as follows. The reel of microfilm is placed on a spindle at the rear of the machine and passed behind a viewing aperture; then a prepared punched card is slipped into the slot between the two. Next, the microfilm picture is illuminated and its position relative to the card adjusted by means of a knurled handwheel. Finally, a lever is operated to guillotine the picture from the reel of film and to press it against the adhesive edge of the aperture in the card. After these

An original document is microfilmed and the picture is mounted over an aperture in a punched card. Data identifying the document are punched into the card, there being 80 columns available over the whole width. The films can be mounted manually, semi-automatically or fully-automatically



simple operations the card is removed from the machine and filed. With this unit, an average operator is able to prepare about 400 cards per hour, and an experienced operator can mount as many as 600 pictures per hour.

If large quantities of cards are processed, a semi-automatic film mounting machine can be used. It has a 14 × 14 in viewing screen on to which the microfilm picture, magnified eight times, is projected. This film is fed automatically from its storage reel, but the punched cards are inserted by hand and the lateral position of the picture is adjusted by manual operation of a control knob. Finally, a button is pressed, and the picture is cut from the reel of film and mounted on the card automatically. Although this machine does not process the cards at a faster rate than is possible with manual operation, its advantage is that the high rate of production can be maintained for very long periods, whereas an operator using the manual method would not be able to keep up this rate of production indefinitely.

If even larger numbers of pictures are processed, a completely automatic machine can be used. Blank cards, together with the continuous length of microfilm, are fed into this machine, in which the protective paper is stripped from the adhesive edge of the aperture, the microfilm picture is centred, guillotined from the roll, and mounted on the card. With this equipment, cards can be prepared at a rate of 2,000 per hour. This machine, which is called the Filmsort Automatic Mounter, can handle continuous rolls of microfilm up to 1,000 ft long. In the event of there being any defect in the microfilm or the card, the machine is automatically switched off.

A useful item of ancillary equipment, especially where cards are to be transferred from one firm to another, is an automatic card-to-card printer. With this equipment, microfilmed records can be reproduced automatically at a rate of 900 per hour.

Printing

A piece of equipment that is fundamental to the operation of the system is the high-speed xerographic printer. It is the Copyflo Model 5B machine, by means of which full-size prints can be obtained directly and rapidly from microfilm pictures. This equipment is identical with the Xeronic computer-output printer, described in *Data Processing* January-March 1959, except in that a special head for the projection of the pictures is fitted in place of the cathode-ray tube and electronic circuits. A batch of up to 500 cards can be placed in the magazine of the machine. The control dial is set manually to select the number of copies required, which can be any number from one to 400. It is best if each batch contains only cards from which the same number of prints are required so that the operator does not need to be in constant attendance to change the setting of the control dial. When the machine is switched on, cards are fed one at a time from the magazine into the machine. This sequence of operations is repeated automatically until all the cards have been cleared, whereupon the machine switches itself off.

Although the width of the reels of paper that can be fitted into this machine is restricted to a maximum of 26 in, and the maximum printing width is 24 in, there is not the same restriction, so far as printing is concerned, on the length. The largest engineering drawings can be reproduced at a size of 36 × 24 in. Reproduction is effected at one of two fixed values of magnification, × 15 or × 20: the value required is selected manually before the start of a printing sequence.

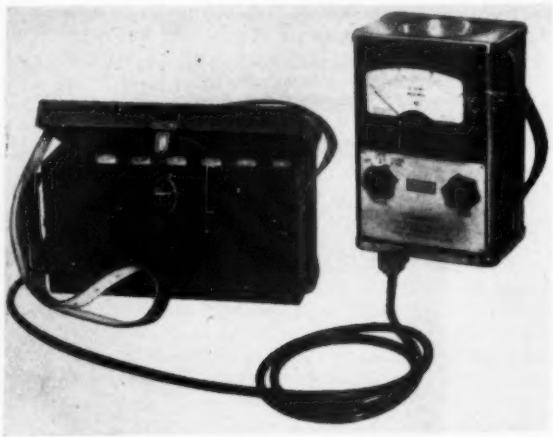
This special version of the Copyflo machine costs £28,000 or can be rented at £600 per month. To assist companies to establish the new technique without the need for such a large capital investment, the machines can also be hired on a meter basis, the payment depending on the number of feet of paper printed.

At the East Pittsburgh Division of the Westinghouse organization, where this system was installed last year, requests for drawings average 3,000 a day, involving the production of approximately 16,000 prints. By virtue of the elimination of the need for tracings and also the saving of 10,500 ft² of floor space, it is estimated that the costs of drawing office supplies in this instance have been reduced by £18,000 per year: a large proportion of this saving is due to the fact that linen tracing cloth is no longer required. In addition, the cost of reproducing drawings has been reduced by approximately £45,000 per annum. Further details of this system are given in the original article.

Battery-Operated Stroboscope

USES of the stroboscope, to measure speeds of rotation or reciprocation of mechanisms, are widely appreciated. However, the usefulness of these instruments in many instances is limited by their dependence on a mains supply of electricity. To overcome this difficulty, Dawe Instruments Ltd., 99 Uxbridge Road, London, W.5, have gone into production of a new battery-operated model, known as the Type 1211 Stroboscope. It is a fully portable model, in which the thermionic valves are replaced by transistors, thereby eliminating the need for heater current to the valve cathodes. By means of the control knob on the front panel of the instrument, the flash rate can be accurately adjusted to any speed between 600 and 15,000 per minute. The stroboscope lamp is neon filled and has a flash duration of only 15 millionths of a second, so that sharp images are ensured at all speeds. A meter on the panel gives a direct indication of the flash rate.

A 12-volt supply is required for the Stroboscope, and can be provided either by the battery unit shown in the illustration, or by a vehicle battery or other source capable of providing a current of 1 amp. The stroboscope unit, which is housed in a metal case measuring only 5½ × 3½ × 7⅞ in, weighs less than 4 lb, and so can easily be held in one hand by means of the handle provided; the battery measures



The Dawe, Type 1211 Stroboscope, operated by a 12 V battery, is compact

9½ × 5½ × 4 in, weighs 9¾ lb and provides sufficient electricity for about eight hours' operation. It is expected by the makers of the Stroboscope that this new instrument will prove equally suitable for use in workshops as well as in the field.

Current Uses of Plastics

A Review of the More Important Applications of Synthetic Materials to Automobile Practice

DURING recent years, the application of plastics in the automobile field has, as in so many other industries, increased remarkably. There are three main reasons for this: they are the greatly enlarged range of materials available, better understanding of the properties and limitations of the different materials, and the rapid improvement in production techniques. Perhaps a fourth reason, rational acceptance by the public, might be added, since it is now generally realized that plastics are not inferior substitutes for wood or metal, nor do they render them obsolete. Not only have plastics taken their true place among the essential ingredients of the modern road vehicle, but the indications are that their use is still rapidly extending.

Glass reinforced polyester resin is fully accepted as highly suitable for car and commercial vehicle bodies, and other components, if they are not produced in quantities large enough to warrant the expense of press tools for the production of steel panels. Numerous bodies are now made of this plastics material, including those for Berkeley, Daimler, Elva, Fairthorpe, Jensen, Lotus, Nobel, Peerless, Reliant, and Turner cars. Polyester-glass is specified also for the Shamrock car, which is not yet in production, while in addition there are several firms producing lightweight sports bodies for fitting to existing chassis. Manufacturing techniques have been considerably improved since such bodies first appeared, and the standard of external smoothness and finish obtained is now equal, in many instances, to that of steel or aluminium bodies.

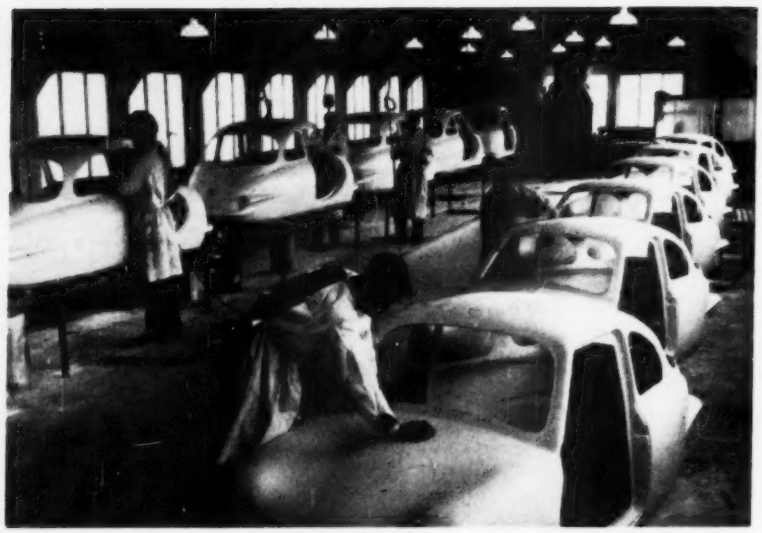
In the commercial vehicle section of the industry, polyester-glass is becoming extensively used for cabs, and for the complete bodies of certain types of delivery vehicles, particularly those used for milk distribution. Among the firms specializing in such construction is Mickleover Transport Ltd., which makes a large number of bodies for electric delivery vehicles, and has also developed a box body of about 400 ft³ capacity for a 3-ton chassis. This body is of the frameless, double-skin type, with a sandwich layer of polyurethane foam to provide insulation. An interesting feature of the construction is that only one mould is employed for the outer skin, and the inner skin is laid up directly on the foam interlayer. The chassis attachment brackets are bonded in, and the floor is a separate one-piece moulding. Painting is minimized by the use of pigmented resin. These bodies, of which over 50 are already in service, are unusually light for their capacity, yet are very rigid by virtue of the sandwich construction.

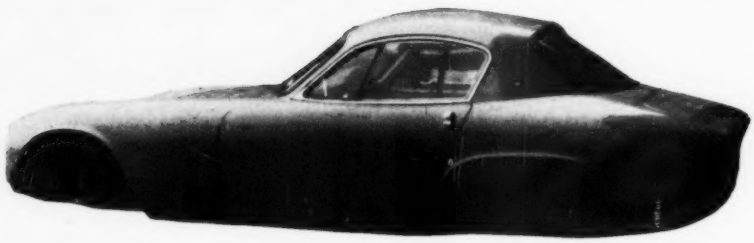
The London County Council is building attractively styled, practical plastics bodies for its Austin forward-control ambulances, which are replacing the earlier, much longer Daimler vehicles. This new ambulance has a cab that is noteworthy for the depth of its wrap-round windscreen, giving an excellent range of vision to the driver. Although the Austin chassis has a considerably shorter wheelbase than that of the Daimler, the interior dimensions of the two bodies are virtually the same. To provide reinforcement where necessary, and attachment points for items such as door hinges and stretcher carriers, an ash framework is bonded into the body shell during lay-up. Here again, a pigmented resin is used so that no major painting is required.

This interesting design has obviously been very carefully worked out to make the best use of the material. Over 20 bodies have already been built, a further 50 or so are in various stages of construction, and 170 more are due to be built within the next three years. The Council's transport department has put its knowledge of glass reinforced plastics to further good use on the Daimler ambulances already mentioned. Because the rear quarters of the metal bodies of these vehicles proved very vulnerable in heavy traffic, replacement sections in pigmented polyester-glass have been evolved and are fitted as necessary. These sections have proved remarkably resistant to damage, and their employment has consequently greatly reduced the amount of repair work required.

Other uses of polyester-glass mouldings include bonnet tops and radiator surrounds for commercial vehicles, also motor-scooter bodywork, sidecar shells, safety helmets, and a variety of weather protective fairings for motor-cycles. The most impressive of these fairings are probably those produced by the Bristol Aeroplane Co., using an injection moulding process that gives a good finish inside as well as

This interesting L.C.C. ambulance on an Austin chassis has a body and cab made of glass reinforced polyester resin. Forward control has been adopted, and a good range of vision is thus afforded to the driver





The experience gained by Bristol Aircraft Ltd. in the manufacture of radomes and other components of polyester-glass is now being put to use in the automobile sphere. This trio of illustrations is of some of the company's current activities. Above left: the production of bodies for the Nobel three-wheeler. Above right: motor-cycle frontal fairings, embodying leg shields, for the Enfield Cycle Co. Ltd. Below left: another body project, the handsome and aerodynamic shell for the Lotus Elite car

outside. They are designed specifically for the machines concerned, and provide protection for the rider's legs and hands, as well as forming a mounting for the headlamp, windscreen and instruments; stowage space for gloves or small parcels is embodied.

Considerable interest has been shown in a new type of vehicle flooring that, because of its resistance to abrasion, should appeal to the fleet operator handling awkward loads. The flooring is of slate-filled polyester resin, reinforced with glass fibre and bonded to a timber sub-floor. Its cost is said to be lower than that of equivalent steel flooring, and the construction is light, rigid and non-corroding.

Among the current applications of phenolic resins is the combined belt pulley and cooling fan fitted to the generators on Ford engines. This moulding is produced by National Plastics (Sales) Ltd., who have also manufactured experimentally a new design of radiator fan of the same material. This fan is 12 in in diameter and, in its standard form, has twelve blades. It has been made deliberately larger than usual, to enable it to run at well below engine speed and thus absorb the minimum power. The mould has been specially designed to permit the number of blades to be varied, as necessary, to suit different sizes of engines.

As can be seen from the accompanying illustration, the blades of this fan are mounted on a relatively large diameter hub. The resultant shortness of the blades gives them ample stiffness, and has no significant disadvantage in terms of operating efficiency, because the cylinder block would exercise an appreciable blanking effect on longer blades of the same overall diameter. This fan has an excellent finish and, since machining and painting are unnecessary, could well be produced at little higher cost than an orthodox, composite unit for the same duty. In addition, it is said to give longer belt life than does a metallic pulley. It is known that several vehicle manufacturers have shown interest in this development. Other products of National Plastics are phenolic instrument panel mouldings, for the Standard Vanguard, also distributor caps and headlamp cowls.

Another material that is finding favour for instrument panels and cowls is moulded fibre; on the Triumph Herald, it is used for the complete facia panel, and for the gearbox cover-panel in the floor. It is also widely employed on other vehicles for components such as demister nozzles, parcels shelves and glove boxes. With the increased attention now being paid to safety in the event of an accident, shock-absorbent underlays for facia edges are becoming increasingly adopted. Several materials are used for this purpose, of which the most common is polyurethane foam, moulded to the desired shape. Its qualities of impact absorption are higher than those of foam rubber, for which reason it is widely featured also for the linings of motor-cyclists' safety helmets. One of the prime requirements is a degree of resistance such that, in the event of an accident, the part of the body that strikes the pad does not crash straight through it on to the hard metal edge beneath.

It is becoming common practice to cover the top of the facia panel with a matt-finish material of dark colour. Such a covering, having a low reflectivity, makes a definite contribution to driving comfort by eliminating the trying reflections in the windscreen that can occur with glossy or light coloured surfaces. Vinyl sheeting is frequently used for this purpose, but it is now being rivalled by nitrile materials, such as the U.S. Royalite adopted by Ford and Vauxhall. Like vinyl, the nitrile sheet is thermoplastic, and so can readily be moulded to the required contours, but it is stated to be tougher and to have greater thermal resistance than vinyl. The U.S. Royalite moulding is supplied already bonded to the resilient underlay that shields the facia edge.

Nylon, owing to its good resistance to abrasion, and its low frictional qualities in the unlubricated state, is finding an increasing application. Certain Continental cars have moulded nylon fans; the material can also be used for gears for lightly loaded drives, in which function its quiet running is advantageous, and it is utilized for certain door lock components. The commendable trend towards the elimination of routine chassis lubrication on private cars has resulted in the adoption, by certain manufacturers, of nylon bushes for steering and suspension joints. Although the material proves very durable in such duties, measures have to be taken to prevent the squeaking of these joints in dry conditions.

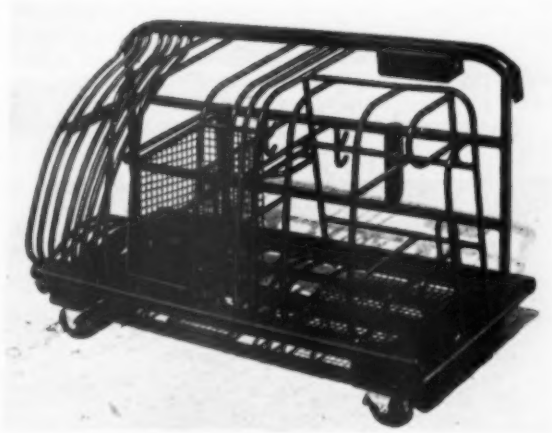
The widespread employment of the various synthetic rubbers for hoses, gaiters and joint washers is well known, and many Neoprene components are to be found on, for example, the new Rover 3 Litre car. Equally familiar is the use, for medallions and motifs, of acrylic mouldings on which metals and paints are deposited. Among the more famous companies specializing in the production of these items for the automobile industry are the Lucas and Wilmot-Breeden organizations.

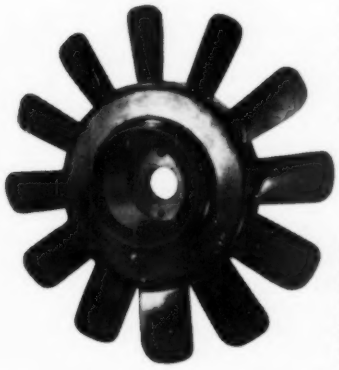
A relatively new field of increasing importance is the plastics coating of metal components, either by extrusion, spraying or dipping. Such treatment may be either decorative or functional. In the decorative sphere, Howard Clayton-Wright Ltd. and Creators Ltd. are marketing a wide range of beading sections comprising an aluminium foil base, having either a natural polished or a coloured anodized surface, with an extruded vinyl coating that preserves the finish of the foil indefinitely without detracting appreciably from its brilliance. The Clayton-Wright product is, of course, used to trim the external joint flanges on the new Austin Seven and Morris Mini-Minor cars.

For more functional purposes, Durable Plastics Ltd. have intensively developed the coating of structures and components by spraying and dipping. A wide range of coatings can be applied, including p.v.c., nylon, p.t.f.e., p.t.c.f.e., polythene and Neoprene. The material used depends on the particular conditions and the required life. Several of the leading vehicle manufacturers are employing stillages coated in this way for preventing damage to parts such as windows and newly plated wheel nave plates. Other uses of the coating process are for a variety of clips, to avoid rattle or chafing, and for steering wheels. It is considered by this firm that plastics coating is a possible alternative to bituminous treatment for the preservation of chassis frames and underbody structures against corrosion.

Two further applications of plastics materials were mentioned in the London Motor Show Review issue of *Automobile Engineer*. One of these is the use for oil seals of silicone rubbers and improved synthetic elastomers, such as Du Pont's Viton, to give greater durability at elevated temperatures. The other application is in lightly loaded bearings, to avoid the need of periodic lubrication. A material commonly utilized for such bearings is p.t.f.e., the Glacier DU range being an example. This material is employed because of its characteristics of low coefficient of friction and good stability over a wide temperature range.

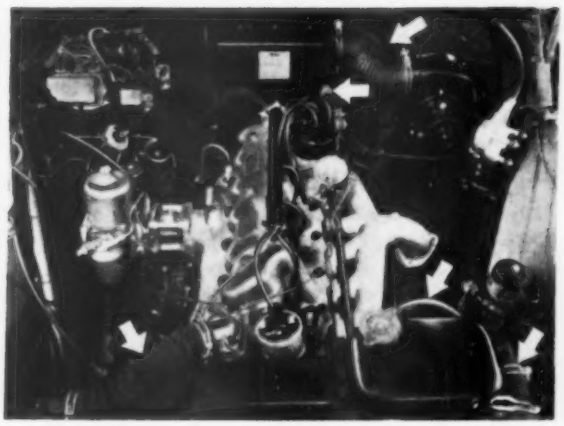
Below: a plastics-covered stillage for windows, produced by Durable Plastics Ltd. Bottom: because of the excellent durability of Neoprene it is used for hoses and other components on the Rover 3 Litre car





Phenolic resin is employed for this twelve-blade fan, an experimental production by National Plastics (Sales) Ltd. The blades are shorter than usual, and the boss embodies the belt pulley

Below: On the Triumph Herald, the facia panel and gearbox cover are of moulded fibre, a material now commonly used for other items such as glove boxes and parcels trays



Routemasters with Air Suspension

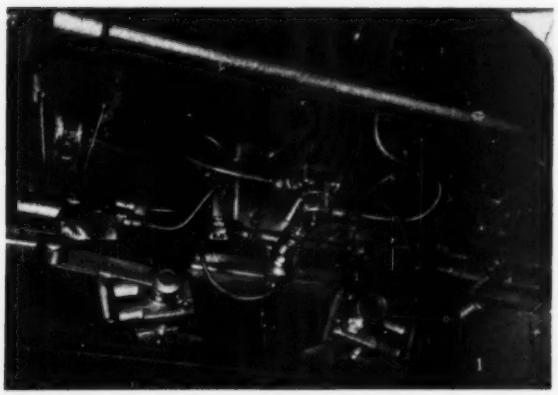
London Transport Executive to Fit 50 Buses with Four Types of Experimental Equipment

OPERATIONAL trials are being carried out by London Transport on 50 Routemaster buses fitted with air suspension, in place of the normal coil springs, for the rear axle. The purpose of this work is to obtain greater riding comfort, regardless of the passenger load carried; air suspension will, of course, confer the secondary advantage of a constant platform height. No change is being made to the coil spring, independent front suspension of these vehicles.

The Routemaster bus is of chassisless construction. At the front end, its mechanical units are mounted on a sub-frame, which is readily detachable for maintenance purposes and is interchangeable between one vehicle and another. The rear suspension assembly comprises two trailing arms, the tail ends of which are interconnected by a transverse member on which the suspension springs seat. Resilient mountings secure the rear axle to the trailing arms, and it is located laterally by a panhard rod. This system was described in the January 1955 issue of *Automobile Engineer*.

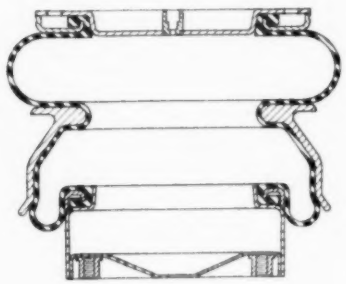
Four different types of air suspension equipment are employed for the trials. In each case, the spring units are secured by the standard fixtures, so that any of the air or coil springs can be fitted at will. With the coil spring layout, telescopic dampers are mounted coaxially within the springs, but lever type dampers are employed with the air suspension. The damper settings are varied to suit the requirements of the individual systems.

Of the experimental buses, 25 are being fitted with Dunlop air spring equipment and the other 25 with the Firestone system. Two types of Dunlop units are used: they are the familiar Pneuride, triple-convolution springs and the new and interesting Dillow springs, with which five buses are being equipped. Large-capacity surge tanks, each with a volume of about 1,200 in^3, are used in conjunction with the Pneuride units to provide an adequately low rate and periodicity. The springs have a total vertical displacement of 7 in, of which the bump movement comprises 4½ in. This gives a periodicity of approximately 80 c/min. The Pneuride system was described fully in the August 1957 issue of *Automobile Engineer*.



The same layout of charging valve and levelling valves is employed on all four air suspension systems being tried on the Routemaster buses. Lever type dampers replace the normal, coaxial telescopic units, and their settings are varied to suit the requirements of each system

An accompanying illustration shows a cross section of a typical Dillow unit. It can be seen that the design embodies a combination of convolution and rolling diaphragm principles. Whereas the upper convolution is of normal shape, the lower one is constrained by a skirt member integral with the ring separating the convolutions. This skirt has the approximate form of a truncated cone. The bottom of the nylon-reinforced rubber diaphragm is anchored to a piston which, in the static load position, just enters the mouth of the skirt. Since the upper part of the piston is hollow, it provides additional air volume, so a smaller surge tank is needed than with the triple-convolution springs. The tank capacity actually used in this installation is 600 in^3, and the resultant periodicity is in the region of 70 c/min.



Sectional view of a typical Dunlop Dillow air spring, combining rolling diaphragm and convolution principles. Separate surge tanks are employed on this particular application

Over small bump-deflections from the static position, the Dillow spring functions virtually as a normal rolling diaphragm unit, giving a low spring rate. At a certain stage, however, the lower convolution is completely collapsed, so the top of the piston is separated from the underside of the intermediate ring by only the double thickness of the diaphragm, which thus forms a resilient stop. As the deflection is further increased beyond this point, the unit acts as a single-convolution spring, and the rate increases rapidly. As in the case of the Pneuride triple-convolution springs, the total deflection range of the 12 in Dillow units employed on these trials is 7 in.

Of the buses equipped with the Firestone components, 20 have the Type 1 Airide units, and the remainder the Type 2. Both are rolling diaphragm units, and they differ only in respect of the profile of the pedestal portions mounted on the transverse member of the suspension assembly. Since the upper, cylindrical portion of each spring unit forms a surge tank of about 600 in^3 capacity, no external tanks are required. Both Airide types are designed for a maximum travel of 7 in, divided equally between bump and rebound strokes; the Type 1 gives a periodicity of 80 c/min, while the Type 2 gives 70 c/min. A description of these units appeared in the June 1958 issue of *Automobile Engineer*.

The air reservoir, charging valve and the levelling valves

are common to all four air suspension systems. This reservoir is an existing Routemaster component, used for the gear-change air servo, and it is fed by the standard compressor; in the reservoir the pressure is 60 lb/in². The charging valve acts also as a non-return valve, to prevent any escape of air from the gear control system in the event of a leak in the suspension system. From the charging valve, air passes through the levelling valves to the surge tanks of the spring units. A warning light in the cab operates if the air supply pressure falls below 45 lb/in². When the bus is unladen, the air pressure in the operating circuit is in the region of 30 lb/in², but it rises to 60 lb/in² at full load.

Dunlop Pneuride levelling valves of normal type are used with each installation; they are mounted on the body structure, and are mechanically linked to the unsprung assembly. To avoid unnecessary response of the valves as a result of wheel movement over road irregularities, a 9 sec delay setting has been adopted. The sensitivity of the valves is such that they will respond to a minimum change of loading height of $\frac{3}{16}$ in, which is equivalent to the entry or departure of 1½ passengers—or approximately one adult and one child.

Scammell Recovery Vehicles

THREE Explorer heavy recovery vehicles have recently been supplied by Scammell Lorries Ltd., Watford, Herts, for service with the New Zealand Army. These vehicles are generally similar to those already produced to the Ministry of Supply specification, except that the cab is of new design. It provides seating for three, including the driver, and is of double-skin construction above the waistline; the steel roof canopy extends forward of the windscreen to form a sun vizor. Heating and demisting equipment is fitted, as also are clips and blocks for stowing rifles, fire extinguishers and other items.

The engine is a Rolls-Royce C6 diesel unit of 184 b.h.p., and it is coupled to the familiar Scammell six-speed gearbox. Top gear is an overdrive ratio and all gears are engaged by sliding dog clutches. Control is effected by a centrally mounted lever operating in a gate. Mounted on the rear of the gearbox is a transfer box, which provides direct drive to the rear axle unit, and embodies the reduction gear for the drive to the front wheels. It is possible to engage and disengage the front wheel drive while the vehicle is at rest or in motion.

For the front suspension, a transverse leaf spring, with pivoted mounting, is employed, whereas the rear axle is attached to longitudinal semi-elliptic springs. The design of the rear bogie follows previous Scammell practice in that a gear case pivots freely on each end of the axle member. Each case contains a train of straight-tooth spur gears that provide a secondary reduction; the outboard gears of the train carry the stub axles for the wheels. This suspension and driving arrangement permits the wheels on either side to ride over a hump 2 ft high without tilting of the chassis frame. The steering and brakes are assisted by compressed air, and couplings for the trailer brakes are fitted at both ends of the frame. For starting on steep gradients, the pedal operation of the brakes can be supplemented by manual control.

These vehicles are intended to operate with 15 ton trailers in virtually any conditions. For this reason, they carry special chains that can be fitted to the rear bogie wheels to form tracks. Also, the cooling and lubrication systems are arranged for operation on gradients of up to 25 deg, combined with a lateral slope of 15 deg. To permit wading and the negotiation of landing craft ramps, full water-proofing is carried out to a height of 2 ft 6 in from the ground.

For self-recovery, a Scammell vertical-shaft winch is fitted; it is driven by a power take-off from the gearbox. The winch carries 450 ft of heavy steel cable and can deal with a direct pull of up to 15 ton. Pulleys and guide rollers on the chassis frame enable winching to be carried out from the front or rear. On a fixed mounting at the rear is an extensible, three-position jib capable of handling 4½ ton loads; a torque limiting device prevents overloading of the jib or cable. The open body round the jib is fitted with lockers and compartments for stowage of equipment and kit.

As supplied to the New Zealand Army, the Scammell Explorer recovery vehicle has a double-skin cab and carries a 4½ ton, retractable jib

Mechanization of Thought Processes

NOTIFICATION has been received from the D.S.I.R. that the full proceedings of the symposium on "The Mechanization of Thought Processes" have now been published; this symposium was held at the National Physical Laboratory in November 1958. The proceedings are in two volumes, covering not only the papers presented, numbering about 40, but also the discussions, in which some 200 scientists took part. They are published by Her Majesty's Stationery Office, and are available from the D.S.I.R., Charles House, 5-11 Regent Street, London, S.W.1; the price of the two volumes in the United Kingdom is 50s, or 52s 11d by post, and in the U.S.A., the price is $9.

Aerostyle Stripcoat

IN PAINT spray booths, unless they have side water walls as well as the normal rear water wall, it is virtually impossible to keep overspray from building up inconveniently. Even with semi-automatic spraying systems, where the amount of paint or sprayed material is carefully regulated to prevent wastage, some paint will adhere to the inside of the booth.

Aerostyle Limited, of Sunbeam Road, North Acton, London, N.W.10, now market a rubber-like material which can be sprayed or brushed on to the sheet metal work, being laid on slightly more thickly than a normal coat of paint. When it is desirable for the booth to be cleaned, all that is necessary is to lift up one corner and strip off the coating which comes away in one piece. The overspray paint, accumulated during many hours of booth operation, is thus swiftly removed, effecting a valuable saving in man-hours.

RAMROD LUBRICATION SYSTEM

Discovery by The Glacier Metal Co. Ltd. Throwing New Light Upon the Bearing Lubrication Problem

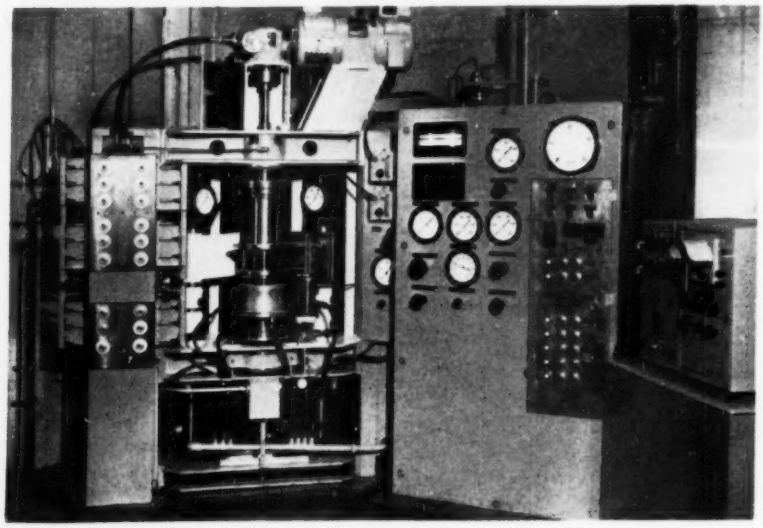
As a result of research work, The Glacier Metal Co. Ltd. have evolved a new system of bearing lubrication, by means of which it is hoped to increase the life of main and big-end bearings of internal combustion engines. Also, it will enable smaller bearings to be employed for the given rating or, alternatively, a larger rating to be adopted for engines currently in production, without increasing their bearing size. In principle, the system involves the injection of lubricating oil at high pressure into the bearing shortly before each application of inertia or gas loading. Although the system is most likely to be used on very large diesel engines for industrial and marine applications, it is worthy at least of consideration for use in certain circumstances with smaller higher-speed engines.

Obviously, the cost of injection equipment will be small relative to the total cost of a large industrial or marine diesel engine, and restrictions in respect of space in these installations are not so severe as in automobile applications. Moreover, the injection equipment will not be as expensive as that currently used for fuel injection: it is much easier to design and manufacture injection elements for lubricating oil than for fuel oil that does not have good lubricating properties, and the requirements in respect of metering are much less stringent.

It has, of course, for many years been realized that bearing failures frequently cannot be accounted for simply by high gas and inertia loadings or distortion or flexing of the shafts or the bearing housings. With the object of discovering exactly what happens in plain bearings under operating conditions, The Glacier Metal Co. devised a machine for the study of the subject. With this machine, a journal is run in a transparent bearing so that the behaviour of the oil film can be studied. Alternatively, the journal can be transparent, so that an actual bearing material can be used for the housing, and the effects viewed through the journal. Generally, Perspex is used for the transparent components, since it is relatively inexpensive and modifications, such as the cutting of grooves, can be easily effected. A disadvantage of this material, however, is its very low modulus of elasticity and, therefore, glass has been used for some of the experiments.

For the movements and changes in condition of the oil films to be observed readily, it is necessary to run the bearings at a very low speed. This involves the application of the principle of dynamic similarity based on the well known formula Zn/p, where Z is the absolute viscosity in centipoises, n is the speed of rotation in r.p.m., and p is the specific loading in lb/in^2. In other words, if the speed of rotation is reduced, the absolute viscosity must be increased or the specific loading reduced. In fact, all three are varied —the reduction in specific loading obviates the disadvantages of Perspex in respect of Young's modulus, so that the bearing cap deflections are of approximately the same order as those that would be experienced with a metal cap. For some of the experimental work, the shaft was rotated at 7 r.p.m., which was about $\frac{1}{70}$ of the normal operating speed, so the oil pressure and bearing loads had to be reduced in the ratio of 1:15 and the oil viscosity raised in the ratio of 5:1.

Simulation of bearing loading is effected by two hydraulic cylinders, with their axes mutually at right-angles, in a plane normal to the axis of the bearing. One cylinder is employed to simulate the horizontal and the other the vertical components of the loading in an engine. The pressures in the cylinders are regulated by cam mechanisms coupled to the mainshaft. These cams can be set to reproduce, in the laboratory apparatus, any polar load diagram required. The load diagram can be shown on an

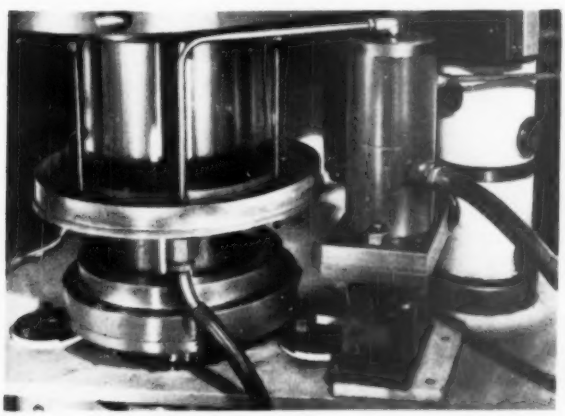


The machine, devised by the Glacier Metal Co. Ltd., for the study of oil films in bearings. On the left, are the controls for the cams used for regulating the load conditions to conform with any polar load diagram likely to be met in practice

oscilloscope screen, so that it can be checked to ensure that it represents accurately the diagram that is obtained in the engine for which the bearing is required.

Observation of bearing films under these simulated conditions of operation have shown that when, on the firing stroke, the gas pressure drives the big-end bearing down, the cap leaves the shaft and the oil film collapses owing to cavitation due to the sudden local enlargement of the clearance. At first sight, this might not appear to matter, since the load is being borne in the top half of the bearing: however, this area of cavitation rotates at approximately half the speed of the shaft, and therefore moves round into the pressure area as the shaft rotates. In fact, the oil film that is broken up by cavitation subsequently receives the full force of the next application of gas load.

This has several adverse effects. First, the effective bearing area is greatly reduced, since the loads can only be transmitted through the oil film, the area of which is small because of cavitation. Secondly, because the clearance between the bearing and the journal is taken up rapidly when the load is applied, the bearing has to withstand not only the static gas pressure loading but also the dynamic

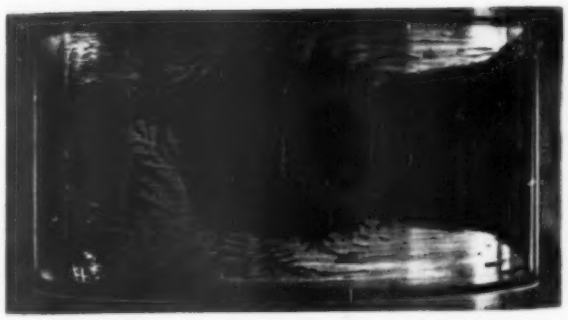


View of the transparent bearing and the Ramrod injection pump that is installed on the equipment illustrated below on the opposite page

loading due to the kinetic energy built up by the movement of the rod assembly relative to the journal. The third factor that adversey affects bearing life is the dynamic effects in the oil film itself. As the oil around the cavities spreads, under the load, and the oil fronts consequently approach one another at high velocity and finally crash together, very high pressures are generated locally, and these cause cavitation erosion which may subsequently lead to fatigue failure.

The position at which the oil hole breaks out on the surface of the journal can materially affect the bearing performance. Experiments with the Glacier test rig have shown that when the hole breaks out at the top-dead-centre position, cavitation at the time when the gas load is applied is extensive. However, it can be improved by advancing the hole so that it is 40 deg ahead of top-dead-centre. Even with it in this position, however, there is still substantial cavitation. This led to the development by Glacier of what they term the Ramrod system of lubrication.

With this system, oil is injected into the bearing just before the application of the load. This has the effect of obviating the cavitation and filling the clearance between the journal and the bearing so that the oil film takes up the load immediately it is applied. On the test rig, the oil was injected at a pressure of 65 lb/in^2, whereas on an engine running at, for example, 500 r.p.m., the pressure required would be about 900 lb/in^2; on smaller engines running at



Typical example of cavitation, as seen through a transparent bearing

higher crankshaft speeds, even higher pressures, of course, would be required. The duration of injection is about 60 deg of crankshaft rotation at speeds up to 1,000 r.p.m.

In a four-stroke engine, the cycle of operations is as follows: lubrication-injection, firing, exhaust, induction, compression, lubrication-injection, firing . . . and so on. Bearings in two-stroke engines are, of course, even more severely loaded since, under certain conditions, practically all the cavitation in the cap half of the bearing is carried round into the rod half by the time the next firing load is applied. In this instance, the sequence of operations is: lubrication-injection, firing, lubrication-injection, firing . . .

There are four main benefits obtained by virtue of the Ramrod injection system: two are thermal and the other two are mechanical effects. First, the oil that is injected is cool, whereas, without injection, practically all the oil in the bearing has been doing work before the firing stroke occurs. Secondly, since the firing stroke begins with a thick film of oil in the bearing, the temperature rise owing to the shearing of that film is lower than it would be if a normal thin film were present. The other two benefits have already been mentioned: they are, the reduction in impact loading due to the taking up of the clearance, and also of the local overloading of the bearing surface as a result of the impact of the fronts of oil as the cavities close.

In practice, since the delivery of oil to the big-end bearings would be effected through the main journals, the injection to cater for the gas loading on the big-ends can also be used to supply the main journals at the same time. In addition, another injection into the main journals would be required to cater for inertia loading which, of course, is much more severe on these bearings than on the big-ends. It is relatively easy to calculate the quantity of oil required to be injected and the tolerances can be large, so the cost of the injection pump is correspondingly low. Variations in viscosity of the oil would not have much effect on the operation of the equipment, because the rate of leakage past the injector plungers would be a very small proportion of the total quantity of oil delivered and, since it is the quantity that is important, the pressure of the injection is not critical. The power absorption of the injection pump is estimated to be about 2 b.h.p. for an engine developing 1,000 b.h.p.

The Glacier Metal Co. Ltd. claim that it should be possible to increase bearing loadings considerably if the Ramrod system is employed: this will enable narrower bearings and correspondingly stiffer crankshafts to be used. Also, the engines can be operated at higher speeds. It is hoped that in this way the output of an engine which, for example, has been previously rated at 800 b.h.p. can be raised to 1,000 b.h.p., with no major modifications other than the installation of the Ramrod system. Thus, the capital cost of the plant per b.h.p. developed would be substantially reduced. Obviously, the work so far done by this company opens up a wide field for further exploration in this field.

Progressive-Rate Suspension

Aeon Rubber Springs in Combination with Normal Springs Enable Vehicles to Fulfil Exacting Operational Demands and Require only a Minimum Modification of Existing Standard Designs

A LARGE proportion of load-carrying vehicles, by the nature of the duties they are required to perform, operate under conditions of no load alternating with full load or even overload. Conventional suspension systems, of constant-rate characteristics, cannot be ideally suited to both the extremes of such conditions. Obviously, the desideratum is a variable-rate system that automatically adapts itself to the load being carried. It is possible, of course, to produce a leaf spring having a progressive rate by special design or by the addition of some mechanical device or equipment, but these expedients are likely to be relatively costly and to add complication to an otherwise simple construction. They have not, so far, been generally acceptable to the vehicle manufacturers. Helper springs, fitted on some British trucks, but more commonly used on American vehicles, cannot be regarded as a solution to the problem, but rather as a palliative to it. While they provide a two-rate system, the load-deflection curve retains the straight-line characteristic of the single-rate system, with a sharp step when the rate changes.

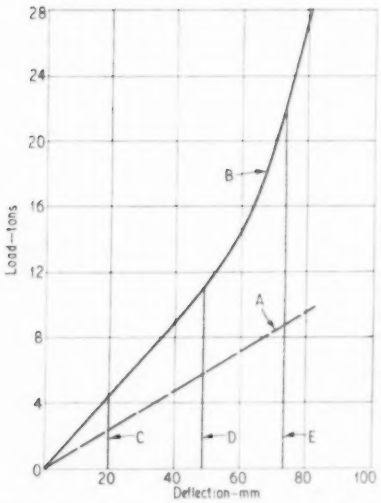
Composite springing systems, comprising existing or modified leaf or coil springs working in conjunction with Aeon hollow rubber springs, have been available for some years and are now being more widely adopted by vehicle manufacturers as well as by operators. Such systems can be designed to give true progression in rate with increasing load, can sustain substantial overloads without exceeding the maximum deflection for which the vehicle was designed, and cannot be "bottomed" under shock loads. They can be applied to all types of vehicle, from the smallest automobile to the heaviest load carrier, require only the minimum modification to an existing standard vehicle and its suspension, are of low first cost, and the rubber springs need no maintenance and have a long working life.

Earlier articles in the *Automobile Engineer** described the Aeon rubber spring, manufactured in Britain by Aeon Products (London) Ltd., 665 Finchley Road, London, N.W.2, and gave examples of typical installations. The versatility of the composite system is an outstanding feature and the range of applications, on all types of vehicles, to meet specific operating conditions is continually expanding. It will not have escaped notice that hollow rubber springs are now being fitted as standard equipment on certain small cars in quantity production, and are reported to figure in the prototypes of others in that class at present in course of development. This article, however, reviews a number of current installations on load-carrying vehicles; from heavy quarry dumpers to articulated tractor-trailer vehicles, and from missile launcher trolleys to ambulances. In each

Typical examples of Aeon hollow rubber springs. The complete range of capacities extends from 50 lb to 17 tons

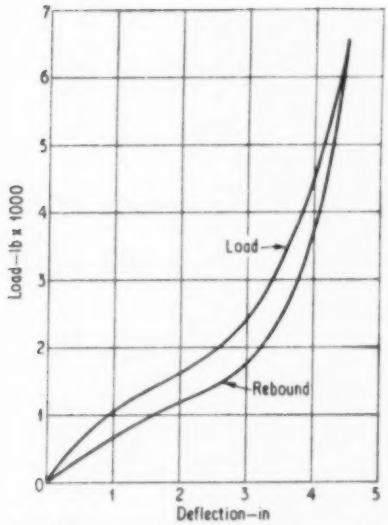
*October 1954 and April 1958.

On Sisu dump trucks, manufactured by Suomen Autoteollisuus AB, Helsinki, Suomi, the load-carrying axle is provided with a progressive-rate, composite suspension system. The K-36SS vehicle shown has a 10½ yd³ body and a load capacity of 18 tons. Total laden weight is 34 tons



A *leaf spring; 7 leaves, 4 in × ¾ in;* **B** *leaf spring + 5 Aeon 540/65 hollow rubber springs;* **C** *truck unladen;* **D** *truck laden;* **E** *shock (2 × static load)*

Loading curve of one rear spring on Sisu K-36, 18-ton capacity dumper



Load-deflection curve of Aeon 760 spring on M.L. missile trolley. Total time base is 16 sec. The hollow rubber springs provide the sole springing means for the front axle. No dampers are required

case the hollow rubber springs were installed to enable the vehicle to withstand especially arduous conditions or to operate under widely varied loadings. In one instance the hollow rubber spring replaces a torsion bar and is the sole springing means on a front axle.

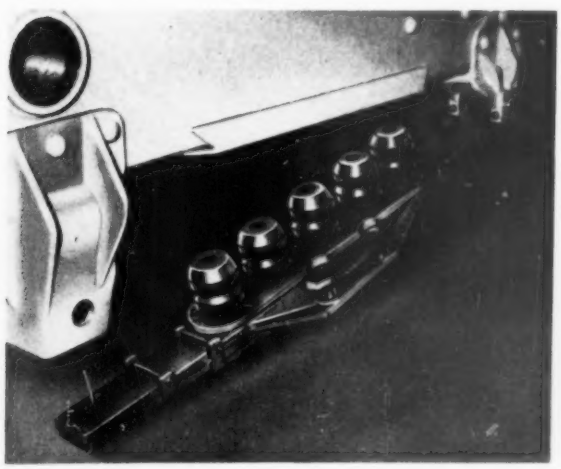
Quarry Dumper

Earth-moving trucks and quarry dumpers are heavy, bulky vehicles and, due to their relative clumsiness, so slow-moving that commonly but scant attention is paid to their suspension. Thus, on most dumper-type vehicles, the front axle only is sprung while the rear axle is supported directly against the chassis frame. Since in the conventional, rear-axle driven dumper by far the greater part of the load is distributed to the rear axle, and the loads in some instances are enormous, designers consider it unwise to complicate the construction by providing this huge mass with a spring suspension. A sprung front axle, supplemented by some springing arrangement provided for the driver's seat, is regarded as sufficient to ensure tolerable riding conditions at the customary operating speeds.

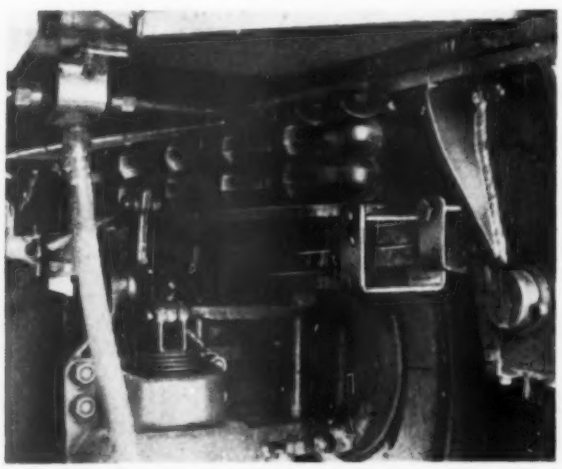
In Finland the manufacturer of the range of Sisu vehicles, Suomen Autoteollisuus AB, of Helsinki, gave special consideration to the design of 18-ton capacity dumpers for operation in an opencast limestone mine. On the site the vehicles were also to be used for stripping off the earth down to the rock to be quarried. When ordinary trucks with a full suspension were used for stripping, their travelling speed was 35 m.p.h. or more, even though the driving distance was only about half a mile. Thus, relatively, they were able to shift considerably greater amounts of earth than the larger-capacity but slower-moving dumpers employed on the same task. At the bottom of the mine the difference was not nearly so marked, but drivers of the unsprung dumpers complained of shocks in operation, backaches, and fatigue.

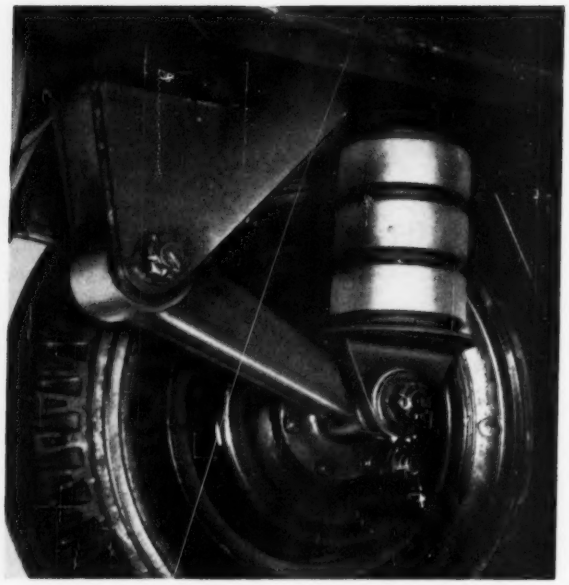
In view of these considerations, a decision was taken that the dumpers for such duties, despite their bulk and weight,

The unique Sisu suspension comprises a slip-end leaf spring assembly and 'a group' of five hollow rubber springs, acting independently



When mounted on the chassis the Sisu suspension occupies less space than a system of similar capacity consisting solely of leaf springs





Single Aeon hollow rubber spring for the independent front-wheel suspension of the M.L. missile launcher loading trolley

should be sprung also on the rear axle. A most interesting composite spring system, including leaf springs by Samuel Fox and Co. Ltd. (United Steel Companies Ltd.) and hollow rubber springs by Aeon Products (London) Ltd., was designed, and both the decision and the design have been amply confirmed by successful continuous operation over more than two years. The additional initial expenditure has been recouped many times over in terms of driver comfort, higher average travelling speed, less maintenance and longer working life of various vehicle structures, above all, of the body. The shocks that a truck of this type with a 10½ yd³ body receives when it is being loaded by an excavator fitted with a 4 yd³ shovel releasing blocks of stone from heights up to 10 ft are very severe.

Due to the relatively poor road conditions in Finland, the builder's customary practice is to estimate the dynamic load as 2½ times the static load, as the maximum speed may rise up to 60 m.p.h. The dumper under review is limited to a maximum speed of 50 m.p.h. when unladen—it cannot reach that speed, of course, when fully laden—so that under all conditions it can be operated at an economical engine speed. The dynamic load is, therefore, lower and is estimated to be twice the maximum static load. This has been proved in service to be fairly accurate, even slightly overestimated. Since in dumper operation the load on the front axle does not greatly increase when the vehicle is driven fully laden, the standard semi-elliptic, leaf spring suspension was retained. As the load on the rear axle, however, is essentially dependent upon the load carried, it was decided that a truly progressive suspension should be provided.

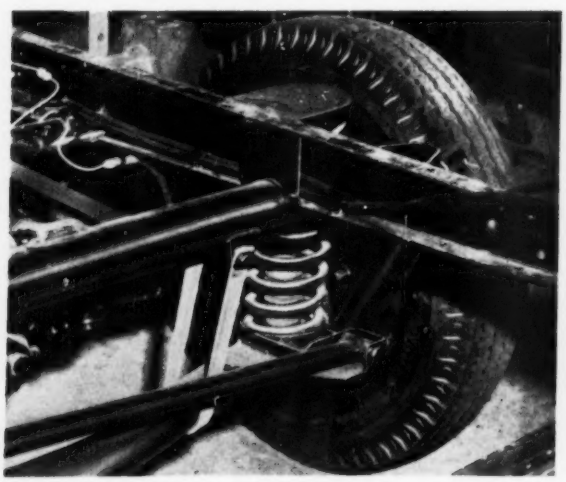
The aim was to use components as simple and durable as possible. To this end, a pair of Fox slip-end springs with seven 4 in × ¼ in leaves was employed, each working in conjunction with a group of five Aeon 540/65 hollow rubber springs. Metal and rubber elements are arranged to operate independently, without stressing each other. Accordingly, the rubber springs are neither secured to nor abut the leaf springs. Instead, they are supported on a platform mounted directly on the axle and engage the underside of the chassis side frame. In combination they provide a spring that at small deflections is soft and almost linear, while approaching full load—about 40 mm deflection—the characteristic curve of the spring commences to rise with increasing steepness. The full deflection of the spring, about 76 mm, corresponds with a 50-ton load on the rear axle.

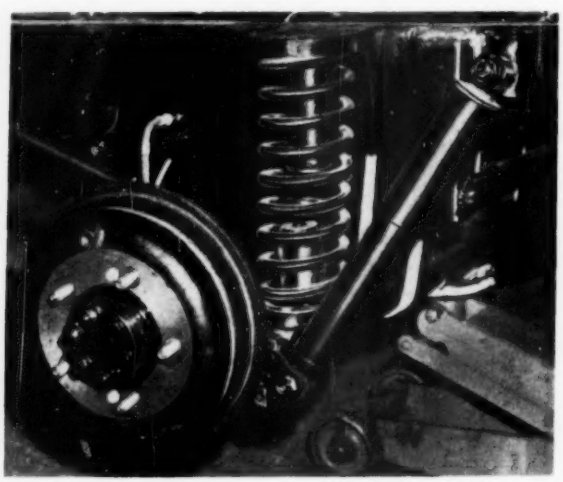
Most vehicles in this builder's dump truck range, from 8-10 ton to 25 ton capacity, are fitted with similar composite springs. All can be provided with rear axle drive or four-wheel drive, as demanded by the terrain and the gradients to be surmounted. Additional to the springs, other items of British-made equipment are Leyland diesel engines to power the smaller vehicles, Rolls-Royce diesel engines for the larger vehicles, and Edbro hydraulic tipping gear.

Main details of the 18-ton dumper reviewed and illustrated are:

Wheel base: 4,000 mm
Tyres all round: 14·00 × 24, 20-ply rating, power grip type
Engine: Rolls-Royce diesel, 184 b.h.p. at 2,100 rev/min
Gearbox: 10 forward and 2 reverse gears, ratios 0·744 : 1 to 15·04 : 1
Rear axle: ratio 9·47 : 1

Progressive suspension system on L.C.C. ambulance with De Dion-type rear axle. The axle-mounted hollow rubber spring and the counter plate are located within the large-diameter helical spring





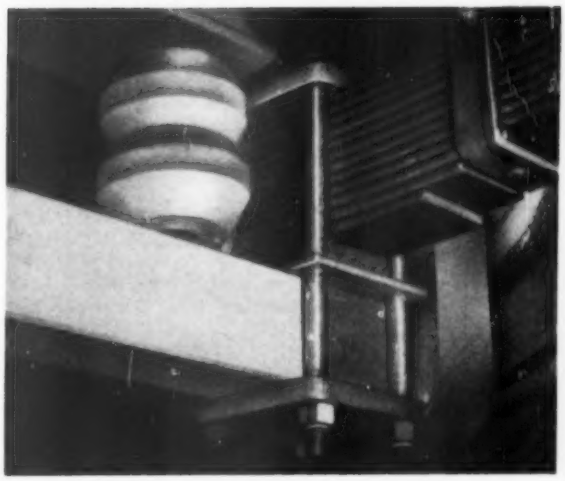
Chassis frame: 20 mm steel plate pressing
Steering: hydraulic powered, adequate for a 15-ton front axle load
Tipping gear: Edbro, tipping to angle of 70 deg in 15 sec with full load
Quarry body: 10 mm steel plate, reinforced with box-section members
Body floor: 13 mm steel wearing plate, 3 in hardwood planking sandwiched between wearing plate and outer plate
Total weight, unladen: 16 tons
Total weight, fully laden: 34 tons.

Missile trolley

When undertaking the design of ground equipment for the transportation and handling of guided missiles, factors quite different from those affecting the aforementioned vehicle will apply. Shock absorption becomes of paramount importance. Careful study has to be made regarding the transport of the missile, complete with delicate equipment and, possibly, fully armed, over all types of terrain. Such considerations make it virtually essential that any spring incorporated in the suspension system should have a progressive rate, low inertia and, so far as possible, be self-damping. Furthermore, the load deflection rate of the spring is of importance, since the overall height of the chassis has to be considered in respect of the unloading of the missile on to a fixed-height launcher.

Following extensive investigation, it was found that the Aeon hollow rubber spring would meet all the requirements. The particular unit installed is the Type 760, with a Shore Hardness Number of 70-75, and having a free height of 9¼ in. The accompanying illustration shows its application as a single-spring shock absorber on the missile launcher loading trolley designed and built by M.L. Aviation Co. Ltd., White Waltham Aerodrome, Maidenhead, for transporting and ground handling the Bristol "Bloodhound" guided missile. This vehicle is of the four-wheeled trailer type, having independent suspension with trailing arms. Torsion-bar suspension is used at the rear wheels, as this method provides a convenient means of adjusting the height of the vehicle at the rear, where it is critical. Its use necessitates the provision of hydraulic shock dampers.

For the front suspension, an Aeon hollow rubber spring, pivotally mounted between the chassis and wheel arm, is employed for each wheel. The wheel assembly is positioned by the trailing arm so that the loading on the hollow rubber spring is always applied axially. By using the Aeon spring the suspension system is simplified, and the cost compares favourably with torsion bar springing. It is easy to install, since no preloading is required. No maintenance is necessary, apart from periodic visual inspection, and replacement is easy. Hydraulic shock dampers are not used on the front suspension, and it will be seen from the graph that self-damping is attained due to the hysteresis of the rubber. The progressive rate of this type of spring is also fully indicated by the curves.

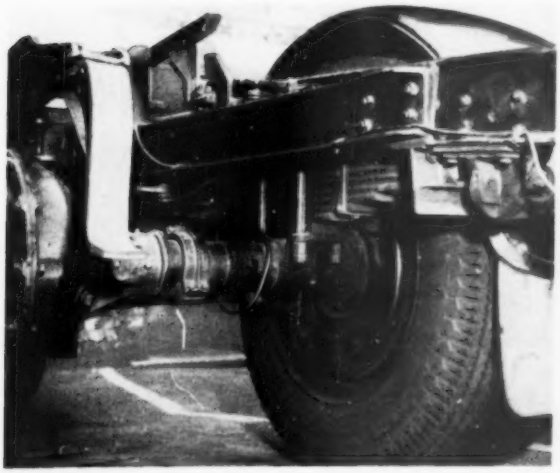


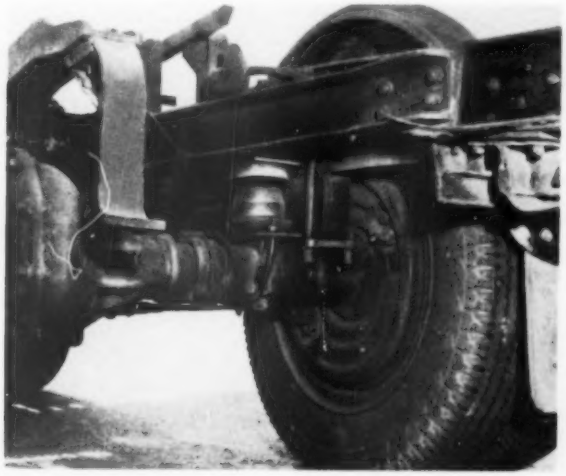
On the Carrimore car-transporter semi-trailer, Aeon rubber springs are fitted to give a progressive rate to the suspension and to prevent roll

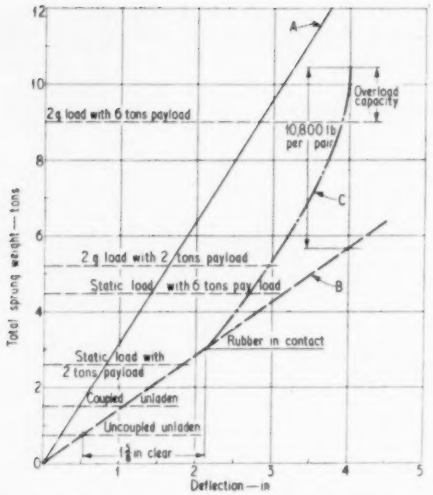
Ambulance

Ambulances also have to be designed for a delicate and sensitive load that must be insulated from shock and, consequently, special care needs to be given to the suspension. Specifically to meet its requirements, the London County Council builds its own ambulances at its Motor Vehicle and Mechanical Equipment Depot, Merton Road, Wandsworth, London, S.W.18. Aeon rubber springs are used in the rear suspension of these vehicles, mainly to enable the ambulance

Ford 4D tractor with Brockhouse interchange coupling for 6-ton "Step Frame" interchangeable semi-trailer. Left, with the 9-leaf spring fitted as standard. Right, with composite spring having 4 leaves and an Aeon 103B/65 rubber spring

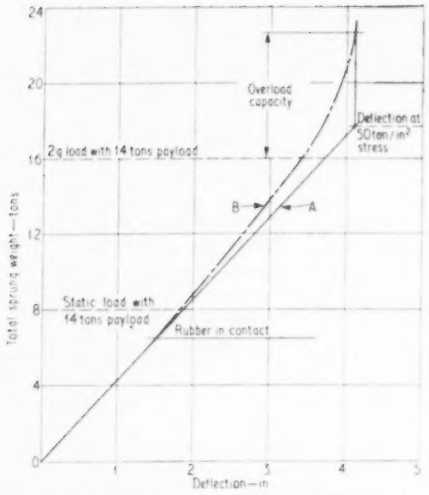






A *standard springs, 51½ in centres, 9 leaves;* **B** *modified springs, 4 leaves;* **C** *Aeon 103B/65 hollow rubber springs, barrel type*

Composite-springs on Ford 4D tractor, with Brockhouse 6-ton interchangeable semi-trailer



A *leaf springs, 50 in centres, 4 leaves 3 in × ½ in and 7 leaves 3 in × ⅜ in;* **B** *Aeon 550/65 hollow rubber springs*

Progressive-rate springs for Brockhouse 14-ton, S.A.E. coupling, semi-trailer rear axle

to cope with widely varying loads encountered in different duties. The chassis is built up mainly from Austin components, with a De Dion rear-axle assembly supplied by the Allard Motor Co. Ltd. On this vehicle the suspension is designed for a normal load consisting of driver, attendant, nurse, and two recumbent patients. Not infrequently, however, the ambulance is required to carry, instead of recumbent patients, up to eight sitting cases, and the Aeon springs are incorporated to take this overload.

As will be seen from the illustrations, the rubber springs are fitted on the axle beam within the coils of the large diameter rear springs. When the loading in the rear compartment of the ambulance exceeds 850 lb, the free ends of the rubber springs come into contact with counter-plates mounted centrally on columns, also inside the coil springs, and take their share of the load. By this arrangement the comfort of the patients is assured under any loading.

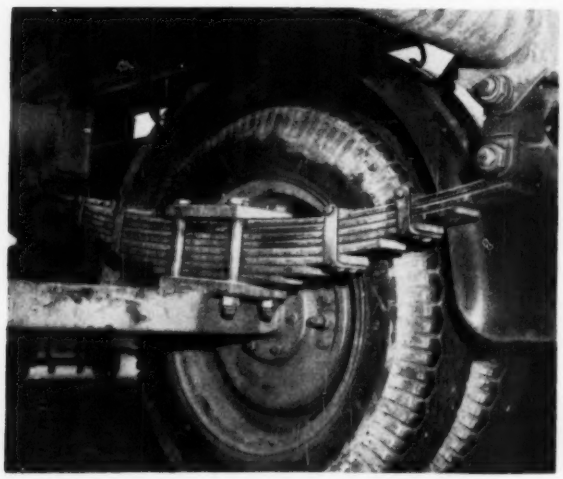
The rubber springs also limit the deflection of the coil springs and thus prevent excessive angularity of the rear-wheel drive shafts. Prototype ambulances with this suspension have been in service for a considerable time, and 220 are to be built during the next three years.

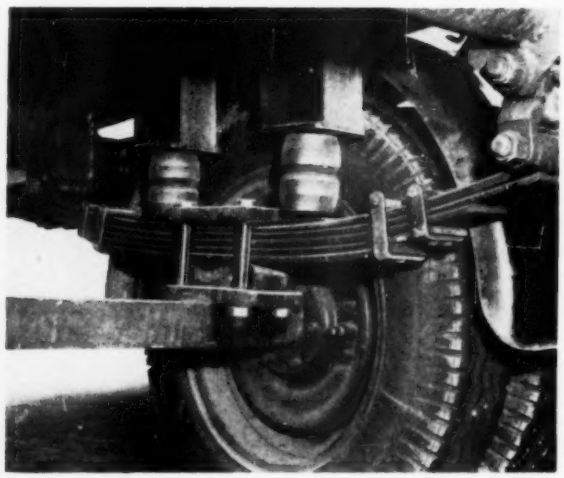
Car transporter

These specialized vehicles, as might be expected, present their own peculiar suspension problems. As with other vehicles operating alternately on no-load and full-load conditions, a progressive-rate springing system is desirable and deflection should be within reasonable limits on account of loading considerations. Since the load is carried on two decks, with the larger portion on the upper deck, the centre of mass of a laden vehicle is relatively high and the need to check any tendency to roll arises.

A typical example is the semi-trailer transporter, with hydraulically elevated upper deck, produced by Carrimore Ltd., High Road, North Finchley, London, N.12. This accommodates five saloon cars, three on the upper deck and two on the lower deck. To provide low-loading facilities the rear axle is cranked and the platform is ramped down towards the rear. Aeon hollow rubber springs supplement

Brockhouse "Step Frame" interchangeable semi-trailer, articulated with Ford 4D tractor. Left, standard equipment is an 8-leaf spring. Right, composite spring having 5 leaves supplemented by 2 Aeon 535/55 hollow rubber springs





the leaf springs on this axle, to provide a progressive rate but, primarily, to prevent roll.

The rubber springs are Type 540/65, having a free height and diameter of $5\frac{1}{4}$ in and $4\frac{1}{8}$ in, and a deflection of $3\frac{1}{8}$ in under the maximum capacity loading of 7,700 lb. They are mounted on chassis brackets and, at a predetermined loading, are contacted by the beam of the axle. In service they have proved to be completely effective, and shock dampers are not fitted to the axle.

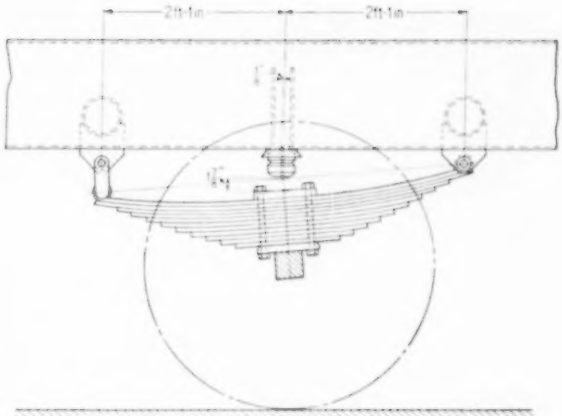
Semi-trailers

Progressive rate springing is particularly suitable for articulated trailers, since their ratio of laden weight to unladen weight is usually higher than that for rigid vehicles. Aeon hollow rubber springs, employed to supplement the standard, or slightly modified, leaf springs of such vehicles, can provide a progressive rate suspension adapted to suit specific operating conditions. J. Brockhouse and Co. Ltd., Wheeled Vehicle Division, Hill Top, West Bromwich, may be quoted as a trailer manufacturer following this conversion practice to meet operator's special requirements. An interesting example is provided by the articulated vehicles supplied by this firm to the North Western Gas Board, Liverpool Group, for the delivery of bagged coke.

The vehicle comprises a Ford 4D—Model ET6—semi-forward control tractor, Brockhouse interchange coupling, and Brockhouse "Step Frame" trailer. As standard, the springs for the driving axle of the tractor have nine leaves, $2\frac{1}{2}$ in $\times \frac{3}{8}$ in, but for the prototype the five lower leaves were removed. The normal height, relative to the axle, of the four remaining leaves was maintained by means of a packing block. For production versions new, lighter springs are fitted. Aeon rubber springs, Type 103B/65, maximum capacity 5,400 lb each, are mounted on cup and saddle brackets bolted to the axle casing. They abut upper steel cups secured to the chassis frame so that the rubber springs have a clearance of $1\frac{3}{8}$ in when the tractor is unladen. Regarding the drastic reduction from nine leaves to four leaves in the normal springs, it will be appreciated that on the Ford 4D all wind-up and fore-and-aft location loads are sustained by the torque tube.

On the trailer, the standard spring has eight leaves. The three bottom leaves on the prototype were removed and a packing of suitable thickness was fitted to maintain relationship. A shaped plate of 8 S.W.G. spring steel, hardened and tempered, was fitted over the top leaf to act as a buffer plate for the two Aeon rubber springs, Type 535/55, maximum capacity 4,500 lb, which supplement each spring. These are mounted on support pillars welded to the underside of the chassis frame.

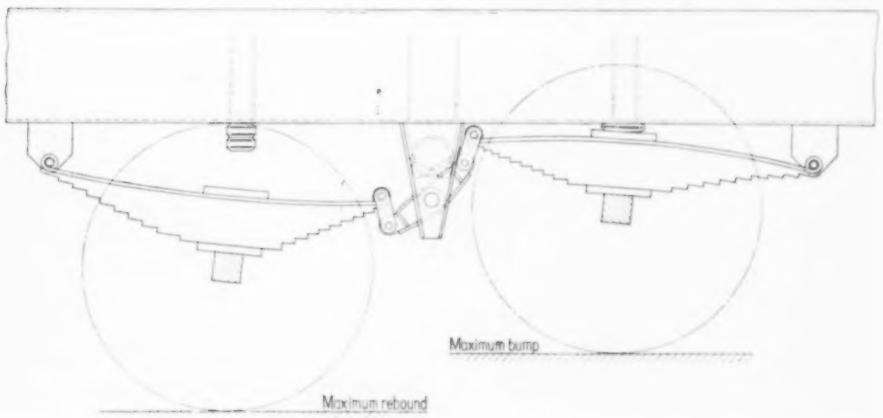
In service these articulated vehicles are performing satisfactorily under all conditions of loading, and coupling of the tractor to the trailer has in no way been impaired by the modifications. Drivers are reported to be very favourably impressed, and the improvement in suspension whilst delivering from diminished loads is particularly marked.



Layout of composite spring for Brockhouse 14-ton payload, S.A.E. coupling, semi-trailer. The Aeon 550/65 rubber spring is mounted with $1\frac{3}{8}$ in clearance when the vehicle is unladen, as shown

Aeon hollow rubber springs will also be used in conjunction with leaf springs on other types of Brockhouse semi-trailers, now under development. A 14-ton payload, S.A.E. coupling, semi-trailer has a single rear axle loaded to the legal limit of 9 tons. In operation, it may be expected, such a vehicle is likely to be consistently overloaded. A single-rate spring designed to cater for overload conditions would have only approximately $\frac{1}{4}$ in deflection when the vehicle was unladen, and a very high periodicity, detrimental to the trailer and load. Aeon rubber springs, Type 550/65, maximum capacity 5,400 lb each, are mounted on the chassis to give progression to the suspension, to limit maximum stress in the leaf spring under overload conditions, and to serve as an axle bump stop. They would also tend to damp out roll. The arrangement of the composite spring is shown, and a graph gives the load-deflection curve.

For a 17-ton payload, S.A.E. coupling, semi-trailer a tandem axle is used. Similar composite springs, including Type 550/65 rubber springs, are used in this layout. The illustration shows the arrangement, with the axles in the extreme bump and rebound positions. In this installation the rubber springs also serve as limit stops for the tandem axle oscillations and helps to damp out axle bounce during braking when the vehicle is in the unladen condition.



Arrangement of tandem axle with progressive rate suspension on Brockhouse 17-ton payload, S.A.E. coupling, semi-trailer. Leaf springs and rubber springs are similar to those used on the 14-ton payload trailer

Norton Automatic Crankpin Grinder

Transfer-type Machine Aggregate for Finish Grinding the Pins of 6-throw Crankshafts Eliminates all Manual Effort in Loading and Unloading

WHAT is understood to be the largest composite grinding machine ever built, has successfully completed trials at the Worcester, Massachusetts, plant of the Norton Company, of U.S.A. Known as the Norton No. 2 unitized, transfer-type, automatic, crankpin-grinding machine, it was designed to finish grind the pins of 6-throw automobile engine crankshafts at production rates up to 60 crankshafts per hour. The machine comprises seven grinding stations positioned laterally to the main transfer conveyor. Pick-up, transfer, loading, grinding, size control, gauging, wheel-dressing, unloading, and return to the main conveyor are all effected automatically. An operator is required merely to overlook the running of the machine, to make any necessary adjustments, and to take action if any one of a bank of warning lights on a control panel indicates malfunctioning of any operation. The complete machine occupies a floor space 90 ft long and 19 ft wide.

In terms of operator effort, crankpin grinding is regarded as one of the most exacting repetitive operations in the automobile industry. Even when mechanical lifting devices are provided, to load and unload heavy shafts at a high production rate throughout a shift is an arduous task. With this new crankpin grinding set-up, physical effort in lifting and handling shafts is entirely eliminated. The shaft is brought to the crankpin grinder by a floor conveyor and an overhead transfer carriage, running on a track at right angles to the conveyor, picks it up and carries it to the single-operation grinding station.

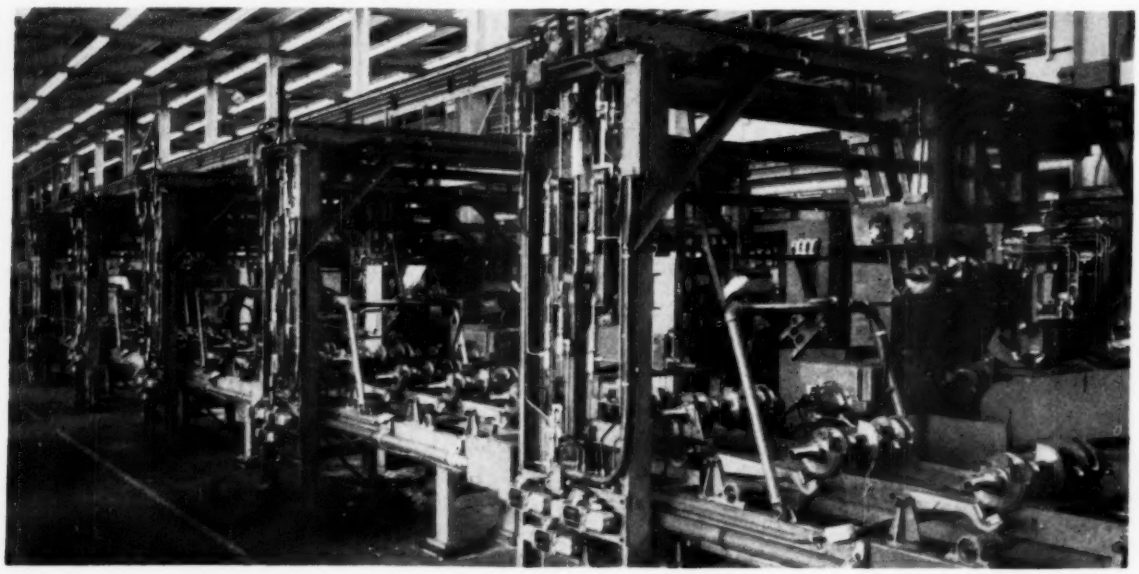
Each transfer carriage has two sets of suspension hooks. One set lifts a ground shaft from the grinding machine and the second set lowers an unground shaft into the throw blocks of the machine as soon as the first shaft is swung clear. While grinding is in progress, the transfer carriage returns the ground shaft to a position over the main conveyor, picks up another unground shaft, deposits the ground shaft on the conveyor, and transfers the unground shaft to a waiting position over the grinding station ready for the next cycle.

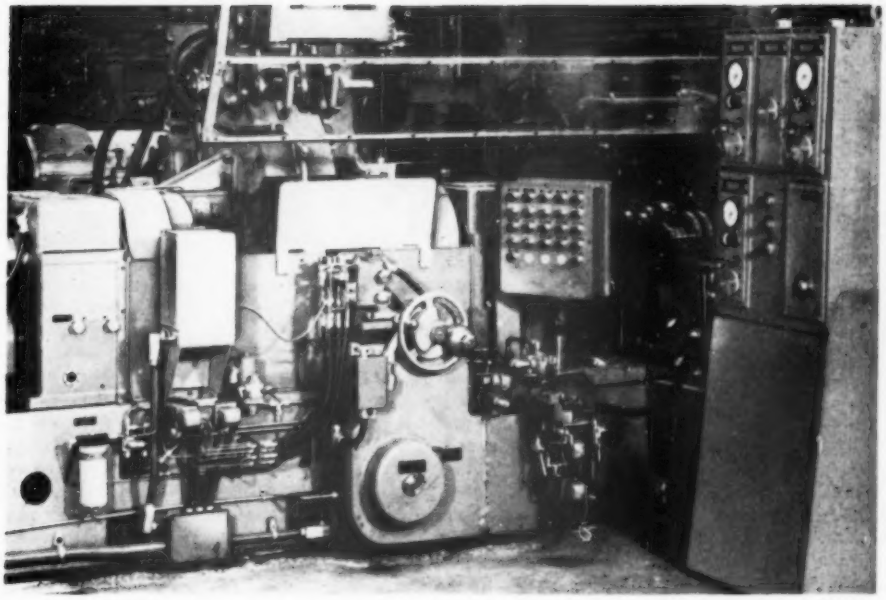
Operating on a 60-sec cycle—production rate 60 shafts per hour—the grinding wheel is out of contact with the work for 17 sec only. During that period the wheel is dressed, automatic devices truing the face of the wheel and forming the fillet radii on the corners. This operation may be effected at each cycle or after a predetermined number of cycles.

To ensure that the particular crankpin to be ground is mounted with its axis coincident with the axis of work rotation, it is essential that the shaft is clamped in the correct angular position in the offset, counterweighted throw blocks. Angular location is accomplished in two stages. The shaft is oriented approximately when it is placed on the conveyor, where it is supported on one main journal and one crankpin and the weight distribution of the shaft turns it the correct side up. The pick-up hooks are arranged to maintain this approximate position and the shaft is placed in the throw blocks. There an end pin rests in a vee block that provides the final angular location, accurate to within 0·002 in of precision.

Axial location also must be precise in crankpin grinding. Once the crankpin is angularly located, an axial adjusting device comprising an oval-shaped cam is advanced and partially rotated between the webs of the crank throw. It

This Norton automatic, transfer-type, seven-station grinding machine finish grinds and gauges the crankpins of 6-cylinder automobile crankshafts at the rate of 60 shafts per hour. The seventh station is a standard Norton crankpin grinder that can be used as a substitute for any one of the six main stations that may be temporarily shut down, and thus maintain production at the scheduled rate





Each grinding station has a separate control for use when setting, adjusting, or carrying out routine maintenance. When the complete line is operated on automatic cycle, however, control is exercised from the master control station, shown here

aligns the crankpin axially so that the wheel will grind an equal amount from each cheek. After alignment, the device retracts, the crank is clamped, and the grinding cycle begins. The headstock drive is so controlled that at the end of the grinding cycle, the throw blocks are brought to rest at a correct position for unloading and reloading.

Grinding machines are designed to mount 42 in wheels on spindles supported at each end for maximum rigidity. The grinding cycle consists of a rapid infeed, fast rate for shoulder grinding, slower feed for roughing, a four-second dwell, and a very slow infeed for final sizing and finishing of the pin. Infeed is controlled by hydraulic valves and sizing is controlled by in-process gauging. When size is reached, air gauges actuate the controls which retract the wheel slide, thus ending the grinding cycle. Compensation for wheel wear and diamond wear are included in the design to ensure consistently correct sizing.

Post-process gauging is done on the ground crankpin when it returns to the conveyor. Three readings on each pin are taken simultaneously to check against taper as well as exceeded tolerances. If the part should exceed tolerance, the respective grinding station is stopped automatically and the operator is warned by means of signal lights. The rest of the machine can continue to operate, the shafts by-passing the one station functioning incorrectly. Results of gauging are shown visually on dial gauges. Each station has independent controls for use in setting up and when making adjustments. One switch changes the station from independent operation to automatic operation controlled from a central master control panel.

The seventh station is actually an extra station. It is a standard Norton semi-automatic crankpin grinder which can be adapted to single-pin grinding and is equipped with a transfer mechanism. It can be used to take over the function of any one of the other stations which may be shut down for wheel changing, adjustment or maintenance. A set of simple controls at the pick-up station on the conveyor is set by the operator to enable the seventh station to substitute for any other station. Alternatively, if additional capacity is needed, the seventh station can be operated as a conventional crankpin grinder with its own operator.

The associate company in Britain of the Norton Company is the Norton Grinding Wheel Co. Ltd. of Welwyn Garden City. The distributors are Alfred Herbert Ltd., Coventry.

Aeropreen Foam Plastics

A RANGE of six polyether flexible plastics foams is now offered to manufacturers by Aeropreen Products Ltd., of High Wycombe, Bucks. This is claimed to be the first time that any plastics manufacturer in Europe has been able to offer such a wide range of this type of plastics foam. There are three grades of prepolymer polyether foam, two of one-shot polyether, and the new Bonded Foam, which is firmer and denser than the foam materials hitherto available.

Materials of these types are widely used for interior trim in motor vehicles. In general, the following are the recommendations with regard to applications for the different types. The prepolymer polyethers, which are offered in three degrees of hardness, have an inherent damping characteristic. This makes them suitable for applications under dynamic conditions, for example, in the padding of seats of motor vehicles and any other instances in which vibration is likely to be experienced. One-shot polyethers, which are offered with two degrees of hardness, have a quick recovery action after the load has been released. This makes them especially suitable for static applications, and they are widely used in domestic furniture and caravans. Bonded Foam, since it is of relatively high density, is best suited for use as thin upholstery pads on a hard base.

Correction

IN THE article entitled "The Cold Working of Steel", which was published in the December 1959 issue, an error occurs in the last sentence of the caption to the illustration on page 528. This unfortunately inverts the sense of the statement. The sentence should, of course, read as follows: "Components of this type cannot be produced in a single operation without the aid of a phosphating process."

A NEW AUTOMATIC STAMPING PRESS

The Precision Flexopress has a Light Alloy Ram Running on Ball-bearing Slides

BASICALLY a high-speed, automatic, stamping press, the Flexopress differs from conventional automatic presses in the design of the ram, the slides, the speed control, and the feed mechanism. Built by the Precision Welder and Flexopress Corporation, Cincinnati, Ohio, U.S.A., in a range of capacities from 15 ton upwards, the 100-ton model is stated to have a production rate of 250 parts per minute. In models of from 15 ton to 50 ton the ram is a high-strength, light alloy casting, approximately only one-third the weight of a similar grey iron casting. Ram slides are formed by inserts of high-carbon, high-chrome steel, and similar slides replace the gibs used on conventional presses. Bearing balls located between the slides are positioned and retained by means of a brass plate operating between the gib members. The vertical position of the ball retainer relative to the slides, of course, varies in accordance with movement of the ram. Preloading is employed to eliminate all play from the ram movement.

This type of construction, incorporating a light alloy ram and ball-bearing slides, is claimed to be entirely new to the press field and to confer substantial advantages in operation. With the plain slide construction used in conventional presses, adequate clearances must be provided and maintained for lubrication. In the Flexopress, by contrast, the necessity for any clearance between ram and gibs is eliminated, since relative movement occurs in rolling instead of sliding contact. An accuracy within 0·0005 in is maintained between the ram and the press bed in all directions. In other words, the parallelism between the bottom of the ram and the face of the bed is within 0·0005 in over the entire operating stroke, as also is the vertical travel of the ram on its central axis.

The Precision Flexopress with ball-bearing slides operates smoothly at very high speeds

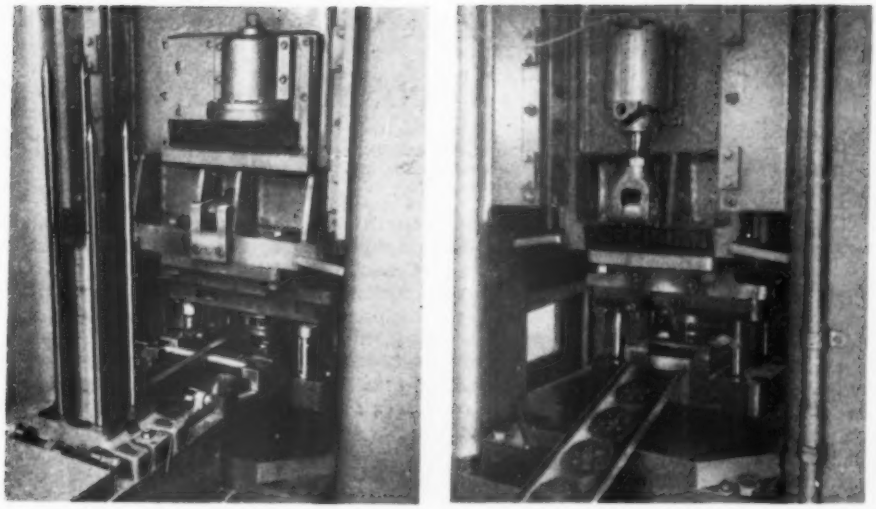
No failures in the ram slides arising from inadequate lubrication have been experienced. In addition, it has been found that throughout long production runs at high speed the ram and the press frame remain cool as a consequence of the anti-friction characteristics of the slide arrangement. Thus the possibility of thermal misalignment of punch and die arising would appear to be obviated.

The strip feed mechanism is of the roll type but is designed as an integral part of the press and, consequently, is exceptionally rigid. Bearing plates in which the roll shafts are mounted are secured to machined bosses on the press framing. Its driving connection from the crankshaft is by a single moving member—a rack—which virtually eliminates the lost motion sometimes encountered in more conventional hook-ups. The rack is mounted on an eccentric on the crankshaft and engages a pinion secured to an overrun clutch mounted to the lower feed roll shaft. This design reduces the feed system to its simplest form and enables the feed rolls to be located extremely close to the die area. Accordingly, relatively light and flimsy strip material can be handled at very high linear speeds. Stock advance is steplessly variable up to the maximum range of the press.

Both the 30-ton and the 50-ton presses are fitted with an air-operated clutch but the 15-ton model is available with either an air-operated or sliding-dog clutch. With the exception again of the 15-ton unit, the presses have a "Revertomatic" steplessly variable drive which enables optimum speed to be selected for the particular component being run. Further, its use allows the stock material to be fed slowly for the first few strokes when starting a run, and thereafter to gradually build up speed. The drive can be set for any operating speed between the high and low limits of its 4:1 ratio but when the press is idling, the drive is always at its lowest speed. Engagement of the flywheel clutch automatically starts the controlled acceleration of the drive to its preset speed of operation. It is possible to change this speed while the press is in motion. When the press is de-clutched, the flywheel returns to its lowest speed at a controlled acceleration rate.

Standard presses, from 30 tons upwards, are all furnished with an automatic brake to control the accuracy of the feed mechanism. Brake pressure is applied only at the end of the feed cycle and is automatically released during the rest of the cycle. In this manner the pressure applied can be greater than can be obtained from a constant-pressure brake. Since braking pressure is exerted only when it is needed, less heat is generated and the brake operates coolly throughout a production run. The feed clutch mechanism is less highly stressed and, consequently, less liable to wear or to require attention as it is not engaged under brake load.

Control components are enclosed in an air-tight cabinet remote from the press frame for easy accessibility. The



These views show the set-up for stamping from circular blanks. Left, spring-loaded fingers slide the blank from the bottom of the magazine stack. Right, stamped parts leaving the press

operator's control station, with push buttons, indicators, and selector switches, is located at the front of the press base, and for convenience may be arranged to either the right-hand or left-hand side. Mechanical functions, such as applying roll pressure and raising the top roll for the introduction of stock material, are adjustable on the outside of the press.

As regards general construction, the main journal bearings are designed as independent units. Bearing housings are made in halves, lined with generously proportioned, replaceable bronze bearings, and are bolted to machined pads on the press frame. The connecting rod bearing is lubricated from a sight reservoir contained in the rod. It is claimed that the sustained accuracy of the ball-bearing ram slides substantially reduces the cost of die maintenance. Close-fitting punches and dies can be run at high speed for hundreds of thousands of pieces without the need to withdraw them for regrinding. Thus, down time for this operation, and consequent loss of production, will be materially lessened or, in some instances, even eliminated.

Exhibition by Courtaulds

DURING the week commencing Thursday, 21st January, an exhibition entitled "Courtaulds in Transport" will be held at Celanese House, Hanover Square, London, W.1. As the name implies, the purpose of the exhibition is to demonstrate the contribution made to the transport industry by Courtaulds Ltd. and its subsidiary companies.

The many products of the group that are used in the industry range from furnishing textiles and tyre cord to chemicals and paints. Close co-operation is given in the development and application of new products to solve new problems. Among the developments beneficial to transport are those affecting factors such as weight saving, durability, comfort, economy and safety.

There will be well over 1,000 exhibits, covering a floor space of 10,000 ft^2. One of the major exhibits will be a 41-seat luxury coach completely fitted out with carpets, upholstery fabrics, heat and sound insulation, luggage racks and other items, all derived from products of the Courtaulds group. Admission to the exhibition, which is not open on the Saturday or Sunday, is by invitation or trade card.

Rocol Molybdenized Greases

IT HAS been announced that Rocol Molysil 33, molybdenized silicone grease, has received Ministry of Supply approval under the specification DTD900/4630. The combination of molybdenum disulphide with a silicone grease results in a lubricant capable of operating satisfactorily over a very wide temperature range. Lubrication is effective, even in miniature ball bearings, at temperatures as low as −90 deg F. Though at present used mainly by aircraft firms, Molysil 33 grease has many possible applications in the fields of precision engineering and scientific instruments; it is the standard lubricant for the Dunlop Maxaret aircraft anti-skid unit.

The various Rocol Molycue greases have many uses in conditions too difficult for other lubricants. They are combinations of molybdenum disulphide with polyalkylene glycols, with or without the addition of thickeners. The main advantages of these greases are their heat resisting qualities, the absence of carbonaceous residue when they are burnt, and their resistance to solvents. Among the grades available are greases suitable for use in ovens and driers, for lubrication of rubber seals, and for plant handling petroleum fluids and other solvents. Further details of these greases are obtainable from the manufacturers, Rocol Ltd., Rocol House, Swillington, near Leeds.

Engine Tuning Equipment

VACUUM gauges are sometimes used for engine tuning and fault finding. A company specializing in such equipment is Automaster, 25 Glenmore Road, Birkenhead, Cheshire. The latest addition to the Automaster range is the De Luxe outfit, comprising a gauge, hose and the necessary fittings, together with a schedule of operating information covering a wide variety of engines. Features of the gauge are a mounting hook, a chromium plated case and a built-in throttling control for damping excessive pulsations. The 2¼ in diameter dial has a matt silver finish and is calibrated with a pressure scale, for petrol pump checking, as well as a vacuum scale: the vacuum scale is in red and is graduated from 0 to 30 in Hg, while the pressure scale, which is in black, is graduated from 1 to 10 lb/in^2.

Vero Auto-Drill

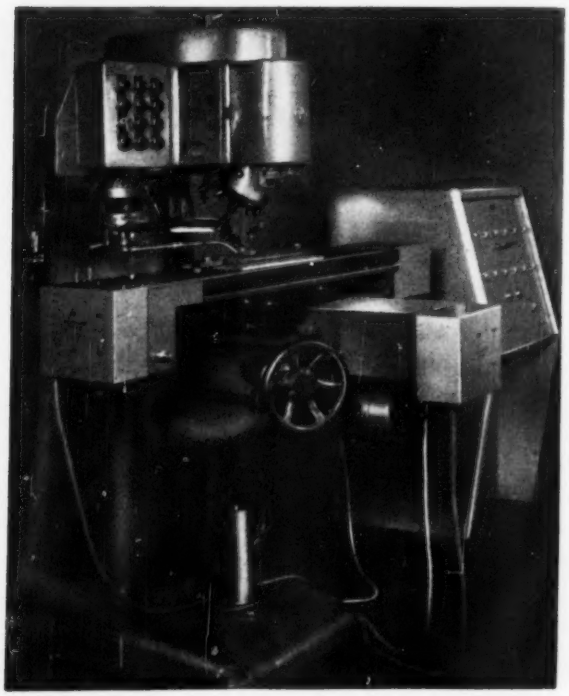
Interesting Six-Spindle Automatic Drilling Machine With Tape Control

CONSIDERABLE savings of time and labour can be effected by automatic, tape control of machine tools engaged on repetition work. However, the high cost of machines embodying electronic co-ordinate positioning equipment makes them practicable only for the larger engineering organizations. For this reason, the new Auto-Drill, a product of Vero Precision Engineering Ltd., Southampton, has tape control by electro-mechanical means. The machine has a six-spindle head, and the Airmec control unit not only selects the tool required but also positions the work under the head.

In the case of the Mark I version, which is now in production and costs £3,600, the maximum diameter drill that can be accommodated is $\frac{5}{16}$ in, for mild steel; up to 600 holes can be drilled or tapped in sequence, with a high overall drilling accuracy. Spindle speeds are variable between 300 and 600 r.p.m., and the maximum distance from spindle to table is 18 in. The uses envisaged for the Auto-Drill include the drilling of castings, chassis frames, plates, cabinets and printed circuits.

A second model is being developed specially for drilling printed circuits and will differ from the Mark I unit in having no knee adjustment or speed-change selection. Also under development is a larger machine, the Mark II, which will accommodate drills up to $\frac{3}{8}$ in diameter. Minor modifications can be embodied in any model to suit the customer's particular requirements. A control panel is provided, so that the machine can be operated manually, instead of automatically, if this is necessary in certain instances.

General view of the Vero Auto-Drill. The position of the table under the turret head and the selection of the required drill are controlled automatically by the Airmec Autoset unit visible in the background



The co-ordinate table measures 32 × 9 in. It has a longitudinal traverse of 24 in and a cross traverse of 12 in. After careful investigation of the advantages to be gained from the use of low-friction slide-ways, Vero Precision Engineering decided that such expensive refinements were unnecessary in this instance. Standard dovetail machine slides are therefore used on the Auto-Drill, with taper-adjustable gibs; also of standard type are the lead-screws, which have aluminium-bronze nuts.

Positioning of the table is effected by the Autoset Type N.271 equipment manufactured by Airmec Ltd., High Wycombe, Bucks. The operation of the equipment is based on the very accurate measurement of the total angular rotation of the two lead-screws. This function is performed by sensing heads known as the positioner units, each consisting of a series of switches of commutator type. Since the unit measures absolute angle, and not change of angle, as on many impulsing systems, the table automatically resumes the correct position after any interruption or mains failure, and no re-zeroing is necessary.

One positioner unit is connected directly to the lead-screw for the longitudinal traverse, and the other to that for the cross traverse. Each lead-screw is driven by a reversible electric motor, and a gearbox and clutch unit. When the lead-screw is approaching its required position, a signal is passed by the positioning unit to the control unit, causing the motor to change to half speed. At another point, much nearer the final position, a second signal is passed, this time to a magnetic clutch in the driving system: this clutch disengages the direct drive and brings in a 25:1 reduction gear. The final run-in is thus carried out at a slow speed; when the position is reached, a third signal is transmitted. This causes the magnetic clutch to be released, whereupon the table stops instantaneously.

It will be apparent from the foregoing that the ultimate accuracy of the system depends on that of the lead-screws. Certain features are incorporated in the design, however, to minimize the effect of inaccuracy in the screws. Errors due to backlash are eliminated by arranging for the final approach always to take place from the same direction: when the table is traversing in a positive direction, all movement is in that direction; but when it is travelling in the negative direction, the table over-runs by about 0·9 in and then returns in the original direction.

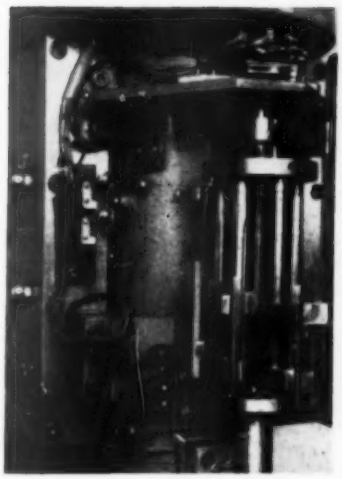
Modern production methods can limit the inaccuracies of lead-screws to 0·0005 in/ft, which is well within the standard required for normal production work on the Auto-Drill. Should greater accuracy be needed, however, it can be obtained by incorporating, in the gearbox and clutch unit, a cam of the correct form to compensate for cumulative errors of the lead-screw. Even without this aid, the overall drilling accuracy is guaranteed to be within 0·003 in and, with special jigging, the variation can be reduced to ± 0·001 in.

The Autoset equipment gives the machine a normal traverse speed of 1 in/sec, so the two approach speeds are 0·5 in/sec and 0·02 in/sec. To minimize loss of time

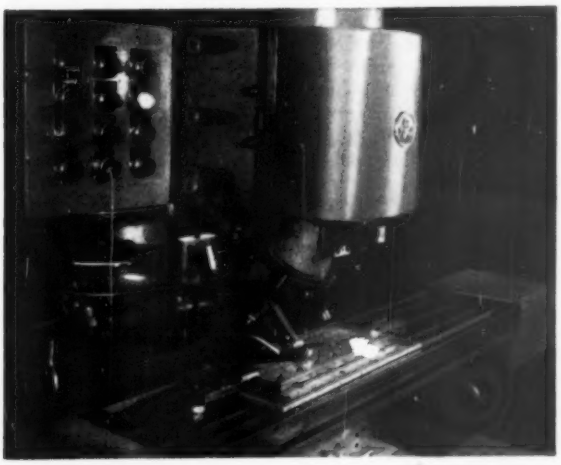
between operations, the highest speed is, of course, maintained until the table is as close as is practicable to the final position. Other time-saving features are that the traverses and the spindle are selected simultaneously, and that the control tape moves to its next setting during the previous drilling operation. As a result, the table begins to reposition immediately the operation is completed.

A Boromat six-spindle turret head is employed, and extensive testing has proved it fully capable of withstanding long periods of heavy duty. The spindles are driven by a d.c. motor giving a choice of six speeds, any of which can be selected on the tape. In addition, a standard three-cone pulley is provided, to permit selection of the best range of spindle speeds for the material being drilled. Feed is effected by an air-hydraulic system. This was evolved by Vero, using Baldwin components, because no suitable proprietary system was available.

The control system is shown in one of the accompanying illustrations. It consists of a turret unit, arranged to index



On the turret unit are adjustable trips to operate the fine-feed and the depth stop controls of each of the six drilling spindles. Air feed is employed



The Boromat turret head has six spindles; drills up to $\frac{7}{16}$ in diameter can be accommodated. A feature of the Auto-Drill is the bush steady bracket, seen behind the head. The control panel is for manual operation

simultaneously with the spindle head. On the turret unit are adjustable trips that operate the fine-feed and depth controls for each of the spindles. Micro-switches transmit the appropriate signals to the Autoset unit. When the "operation started" signal is received from the switch system, all table movement and spindle indexing controls are locked, and the tape is allowed to feed on. Conversely, the "operation completed" signal frees the controls to allow the table to move and the head to index if necessary. Above the turret is mounted a standard 6-position rotary switch, which controls the spindle selection and speed, in accordance with signals received from the Autoset unit.

Once the table has been correctly positioned, and the appropriate spindle selected, a starting signal is sent from the Autoset to the main air-control valve for the spindle feed. This valve admits air into the air-hydraulic system, causing the spindle in use to be moved downward until the fine-feed micro-switch is operated. Through the medium of a solenoid, this switch actuates a valve, which diverts the hydraulic fluid through an adjustable restrictor valve, whereupon the spindle is moved downward at the selected feed rate.

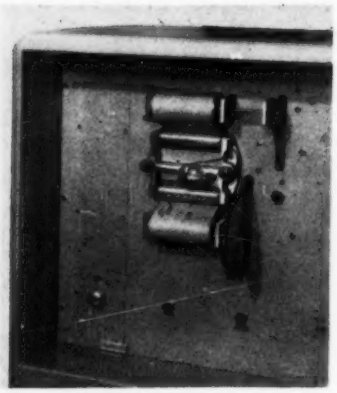
When the depth-stop micro-switch is tripped, the main air-control valve is reversed, and the spindle is then returned to its top position. The return passage of the fluid is normally unrestricted, to avoid delay in the upward travel of the spindle. However, if it is necessary, for certain operations such as tapping, for the upward movement of the spindle to be on fine-feed, this can be arranged by punching the appropriate signal on the tape. As was mentioned earlier, the trips operating the fine-feed and depth controls are adjustable. This adjustment enables them to be set in any position within the range of the feed traverse, to suit the particular operation of each spindle.

Spindle selection is initiated by a signal from the Autoset unit. If the head is not indexed on the spindle indicated by that signal, it commences to index in a clockwise direction, and continues until the correct spindle aligns with the rotary switch already described. The switch then closes a relay to prevent further indexing, and to permit the Autoset to give the starting signal for the drilling operation. This signal cannot be given until the correct spindle is selected and the table is in position.

Where tapping is required, a slow-speed gearbox is necessary. This is available as an extra, as also are Boromat tapping heads, which replace the normal drill spindles. The control arrangements ensure that the slow-speed gearbox is engaged only when a tapping spindle is selected. Since the Boromat head is of the normal automatically reversing type, it is only necessary to set the depth-stop in the usual way.

The tape used for controlling the drilling programme is of vinyl material, 4 in wide, 0·004 in thick and about 70 ft long. It is robust, easily corrected if wrongly punched, and has a virtually indefinite life. Disposed at equal intervals across the tape are 14 longitudinal columns of hole positions. For one operation of the machine, a full-width, 5-deep block of hole positions is required. The holes are punched according to a code representing the desired settings. On the standard Auto-Drill, five columns are used for the X ordinate and another five for the Y ordinate; other columns are used for spindle and speed selection, and for any special services that may be needed. These include tape run-back, and an automatic stop, to halt the programme for swarf clearance, tool changing or routine inspection. For the punching of the tape, a keyboard type punch is normally employed. A semi-skilled operator is required, working directly from drawings or from a planning chart.

At the back of the Autoset control cabinet is mounted the programmer unit, shown in one of the accompanying illustrations. In the unit, the punched tape is fed from one roller to another, and is stopped in the appropriate position for each operation, by means of a light, which shines through



At the rear of the control cabinet is the programmer unit. The punched, vinyl tape, which initiates the signals transmitted to the machine, can be seen in this view

a location hole in the tape on to a photo-transistor. Airmec Ltd. prefer this method to the use of sprockets and claw mechanisms, because the latter are not only complicated but are also liable to damage the tape. The information on the operative portion of the tape is read by spring-loaded pins; these only bear on the tape when it is stationary, so that wear is negligible. As a result of the pin reading, the appropriate positioning and tool selection signals are passed on to the control unit. A dust-proof cover protects the tape winding mechanism, and an interlock switch prevents operation of the equipment while the cover is removed.

To give full flexibility of operation, three manual controls are provided on the programmer unit: these supplement the automatic control. A push-button can be operated to cause the tape to be rewound to its starting point, thereby permitting the drilling sequence to be interrupted and restarted at any time without waiting for completion of the programme. This feature is an advantage in the event of a fault being discovered in the material, or of drill breakage. The second control, the stop sequence push-button, is employed to allow swarf removal or tool changing to be effected, and the programme is restarted at the same point when the start button is pressed. Thirdly, there is the tape-advance switch, operation of which causes the tape to run on until the switch is returned to normal. By this means, intermediate sections of the tape can be by-passed if desired.

Another advantage claimed in respect of the Auto-Drill is the simplicity of the jigging requirements. Normally, only a single locating and holding fixture is needed, though a drill plate is advisable where thin components are being batch drilled, in which case overall clamping is essential. If such a plate is necessary, the method adopted by the manufacturers is to produce it on the Auto-Drill, using the tape prepared for the actual components. For short runs, hardened bushes in the drill plates are then unnecessary.

Quality Control of Sheet Metal

Equipment for Flaw Detection at Continuous High Speed, Developed by the Chrysler and Sperry Companies

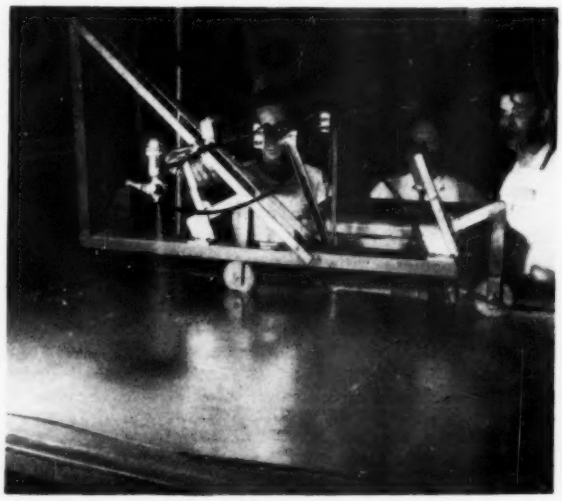
WHILST the use of coiled strip material, high speed shear lines, and integrated automatic shearing presses has speeded up the production of blanks for sheet metal components, the desirability of inspection of blanks for imperfections before pressing remains. This tends to be a time-consuming operation that may retard the throughput rate, but to omit it leaves the hazard that a blank may rupture in the forming press.

Hitherto, it was regarded as impracticable to check by ultrasonic inspection methods sheet metal being fed at a speed of 200 ft/min. Persistent investigation by a Chrysler Corporation research worker resulted in the conviction that the problems could be solved by the use of standard items of equipment. After continued experiments, conducted in collaboration with Sperry Products, Inc., of Danbury, Connecticut, a system was developed that could function satisfactorily with the material to be inspected running at the stipulated high speed. Flaws, inclusions, and laminations are revealed by a change in the pre-set pattern of the trace on an oscilloscope. This can be arranged to give a sound signal and to trigger a suitably aligned spray gun to mark the faulty area with a dye.

The scanner, which incorporates a Sperry "Reflecto-scope", is located on the shear line immediately before the shearing press. It identifies the precise position of faulty metal, which can be cut out of the strip with a minimum of waste. Obviously, with the latest types of continuously operating feed lines with synchronized flying shears, this operation could be performed automatically. The system has already been put into operation in a Chrysler Corporation stamping plant in the U.S.A. Experience has shown a marked reduction in rejections of body stampings effecting, it is stated, a saving of thousands of pounds in a single month.

Following the success of the system for the inspection of sheet metal, it is now being investigated as a means of non-destructively checking spot welds. There are approximately 3,500 spot welds in a modern car body and, currently, examinations to determine whether these form satisfactory metal unions are extremely costly. An ultrasonic method has been devised, and is now undergoing tests, that would accept or reject 300 spot welds every 4·5 seconds, that is, at the rate of 4,000 welds per minute. The use of these ultrasonic checking systems, it is suggested, could provide the Chrysler Corporation with a measure of quality control not previously achieved in the American automobile industry.

The prototype ultrasonic scanner in operation with the strip metal running at a speed of 200 ft/min. Faulty spots are automatically sprayed with a purple dye and can be automatically cut out of the strip



New Plant and Tools

Recent Developments in Production Equipment

A PRODUCT of the Coventry Gauge & Tool Co. Ltd., this is the only British-designed and British-built jig grinding machine. Designated the "Matrix" 56-12-18 jig grinder, the machine can work hardened materials without distortion and to close tolerances, thus avoiding the problems arising when hardening finished components. The spindle head is completely enclosed and fully protected against the ingress of dust and dirt. Carried on a vertical slide running in generously proportioned ways extending the full depth of the machine, the head has a maximum traverse of 16 in. Vertical movement is powered by an independent motor controlled by push buttons on the apron and a scale indicates position. Limit switches prevent overrun.

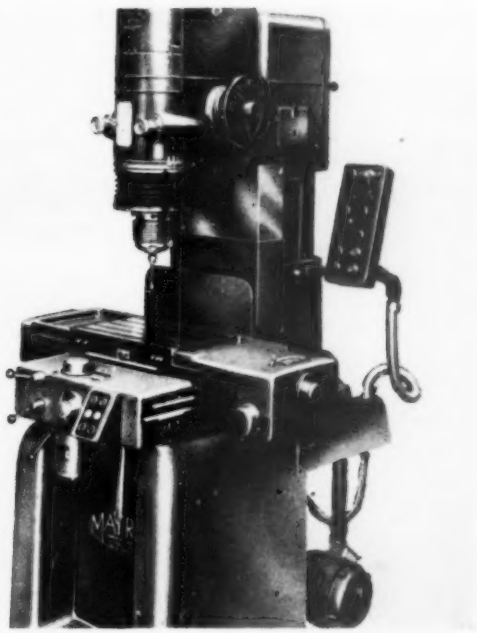
The four spindle speeds range from 12,000 to 50,000 rev/min, and an important feature is the ability of the spindle to maintain a constant speed irrespective of load. A preset speed can be selected or repeated at any time. For imparting radial feed whilst grinding, control is effected by means of a head-mounted dial graduated in divisions of 0·0001 in; the spindle being mounted on a cross slide having a travel of 1·25 in. Either diamond-impregnated stalks or grinding spindle quills may be used in the collet nose. As standard, the maximum diameter hole that can be ground is 5 in but an adaptor plate, available as optional equipment, will increase the capacity to 9 in diameter.

Quill speeds steplessly ranging from 25 to 225 rev/min are provided by a variable speed motor. Vertical travel is either manually or power operated to suit the work undertaken, and the power traverse is smoothly variable between the rates of 10½ and 105 in/min. The quill can be traversed to the top of its maximum stroke of 4 in without disturbing the setting of the traverse stops, thus permitting gauging and inspection of the work with the minimum loss of production time. Segmental grinding can be performed by manually moving the quill through a predetermined arc; a graduated control dial enables this operation to be effected with a high degree of accuracy. Another useful feature is that the quill can be inclined up to an angle of 1½ deg, giving precise control for parallelism and facilitating the grinding of tapers at included angles up to 3 deg.

Dimensions of the work table are 18 in by 12 in and longitudinal and cross traverses are 12 in and 8 in respectively. Movements are effected by hardened, thread-ground leadscrews, and a corrector-bar system ensures precision settings. Each movement is operated by a separate motor, controlled by push buttons on the apron, at a rate of 32 in/min. An automatic brake prevents overrun and an overload clutch precludes any possible damage to the leadscrews. Setting is rapidly and simply effected by using the power traverse for approximate location and making the final, precise setting by hand controls reading to 0·0001 in by vernier. These dials are mounted below the table surface, adjacent to the controls, and are protected by armour-plate glass.

Among the available additional equipment is the spline and slot-grinding attachment illustrated. This can accommodate grinding wheels from ⅞ in to 1¼ in diameter and is powered by a ⅓ h.p. motor providing speeds of 13,000

Matrix 56-12-18 jig grinding machine and, on right, the spline and slot-grinding attachment available as extra equipment
Rockwell Machine Tool Co. Ltd.



and 20,000 rev/min. Micrometer-controlled compound slides, with verniers reading to 0·0001 in, enable adjustments to be made without moving the compound table of the machine or disturbing the coaxial setting of the circular table relative to the quill.

Sole selling agents of the Matrix 56-12-18 machine are the Rockwell Machine Tool Co. Ltd., Welsh Harp, Edgware Road, London, N.W.2.

Automatic backing-off machine

An electro-hydraulic automatic backing-off machine for the accurate generation of the clearance angle on such tools as hobs, thread-milling cutters, form-milling cutters, and the like has recently been developed by the firm of Reinecker, of Einsingen, West Germany. It is intended as a high production machine; the design and construction permitting the use of the fastest cutting speeds for any specific material and the automatic sequencing of operations substantially reducing unproductive time. The versatility of the machine renders it suitable for a wide field of application. Hobs and cutters may have straight or helical flutes and radial and angular relieving be undertaken.

The backing-off tool is actuated at a high cutting speed by a crank-driven ram which is suspended on tension springs to counterbalance its weight. Cross feeding of the tool for stock removal can be effected either manually or automatically, and the clearance angle on the component is generated through a cam-controlled movement of the ram head slide. The workpiece is mounted on an arbor between two support members and driven from the workhead. Longitudinal traverse of the main slide carrying the workhead is either manually, using a two-speed handwheel, or by power. Used when producing helical cutters, the power traverse is controlled by a lead screw having an accuracy of 0·0008 in in 12 in.

In operation, the backing-off tool reciprocates at high speed and is rapidly advanced to the stationary workpiece. Then stock removal begins by plunging into the work until the deepest point of relief is reached, producing a vertical surface on the outside diameter. At that stage a limit switch is actuated and the work is caused to revolve. The down stroke of the cutting tool and the rotation of the work, in combination, have a generating effect, and the ram-head slide commences the return movement that produces the clearance angle on the work. As soon as the next tooth space is reached, rotation of the work is interrupted automatically and the cycle repeats. After one full turn of the work spindle the workpiece is completely finished and the machine is automatically stopped.

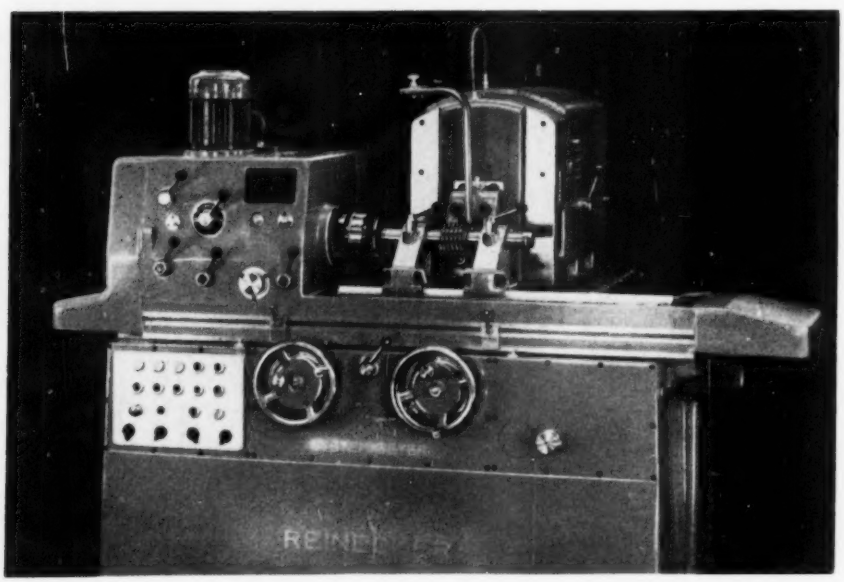
Due to the high-speed cutting action of the machine, the productive capacity is higher than that of a relieving lathe. Furthermore, the automatic control of the operational sequence, once the work is loaded and clamped, allows an operator to supervise and run several machines. The machine can accommodate work up to 11 in diameter and the longitudinal travel of the table is 20 in. Twelve main spindle speeds are provided, ranging from 0·5 to 24 rev/min. The maximum backing-off stroke is 0·875 in and the maximum plunging depth is 1·0 in, at plunging speeds up to 20 ft/min. Change gears in the work head can provide a wide range of pitches; 0·01 to 8·0 in for thread pitches, 50 to $\frac{1}{2}$ for diametral pitches, and 8 to 360 in for flute spiral pitches.

The distributors of Reinecker machines in the United Kingdom are Stuart Davis Ltd., Much Park Street, Coventry.

Bevel-gear blank checking machine

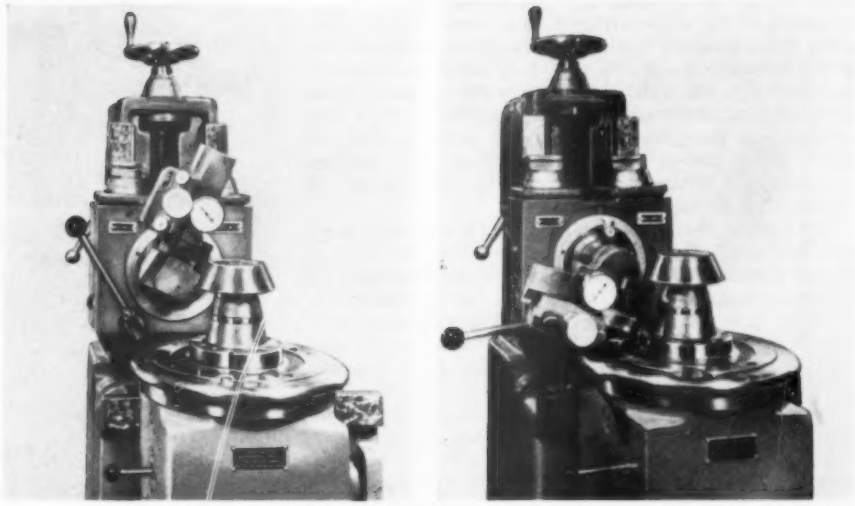
To speed up the checking of bevel-gear and hypoid-gear blanks, usually performed by hand, the Gleason Works, of Rochester, New York, U.S.A., has recently introduced an automatic machine. The early detection of errors allows blanks to be corrected or rejected before time and money are expended on subsequent operations. Known as the No. 15 Blank Checker, the machine can handle blanks from 2 to 15 in diameter, with a distance from spindle nose to crown of from 2 to 10 in. The travel of the indicator is 2 in over the face angle and 1 in over the back angle. Floor space occupied is 22 in by 32$\frac{1}{2}$ in.

In operation the blank, for gear or pinion, is mounted on an arbor on the work-spindle table, which has a horizontal adjustment and a double-dial control for setting the outside diameter. The measuring head has a vertical adjustment with a double-dial control to set the crown-to-back dimension. When the angular slide carrying the indicator is set to the appropriate face angle or back angle, the blank is



Reinecker automatic backing-off machine

Stuart Davis Ltd.



Gleason bevel-gear blank checking machine. Left, set for face angle check. Right, arranged for back angle check

Buck and Hickman Ltd

trammed with the indicator. Since the indicator slides parallel to the face cone angle, a perfect blank will register zero on the indicator in all positions.

Should the indicator reading vary as it is traversed across the surface of the cone, a face angle error is revealed. If the indicator displays a consistent reading differing from zero, the face angle is correct but the crown-to-back dimension is in error. Back angle errors are made apparent in a similar manner; a varying indicator reading showing an incorrect angle and a constant off-zero reading indicating an error in diameter.

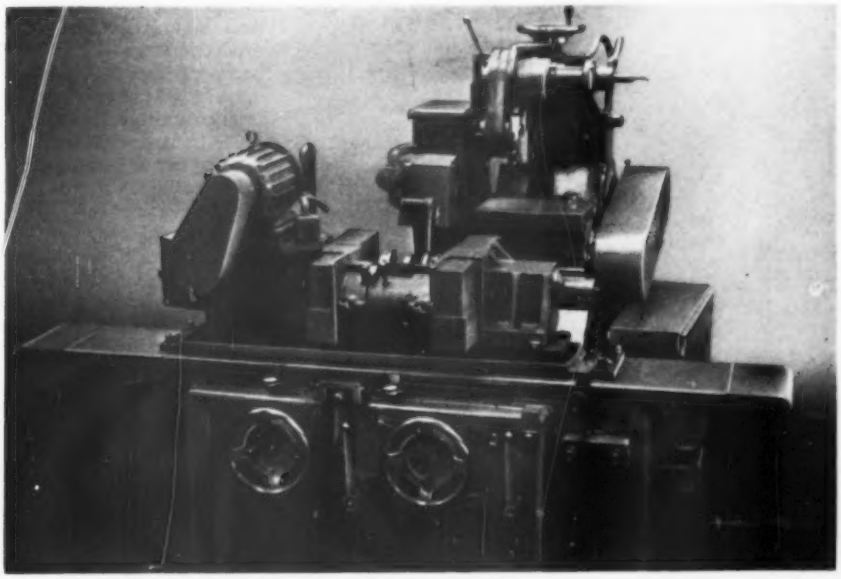
A handwheel control is provided so that the blank can be checked while it is rotated on the work spindle. With the indicator probe set to the centre of the gear face and to read in the axial direction, a check of run-out is obtained. To check for concentricity, the probe is placed on the back cone and set to read in the radial direction as the blank is rotated.

Selling agents in the United Kingdom are Buck and Hickman Ltd., Otterspool Way, By-pass, Watford.

Small crankpin grinder

Designed specifically for the production of small single and double-throw shafts, this new crankpin grinder exemplifies the principles of rationalized manufacture and unit construction. Fundamentally, the machine is a standard, 12 in swing, cylindrical grinder fitted with a special headstock and tailstock fixture for crankpin grinding. This special fixture can be removed as a unit from the worktable, and if replaced by a conventional workhead and tailstock the machine can be used normally for plunge-cut or traverse grinding. Built by Keighley Grinders Ltd., a member of the Newall group of companies, the Model L120 machine is available in two sizes to accommodate shafts of 16 in and 20 in length respectively. In both machines the maximum swing is $4\frac{7}{8}$ in.

Driven by a $7\frac{1}{2}$ h.p. motor, the nitralloy spindle runs in steel-backed, white-metal bearings, automatically lubricated through oil rings from a sump in the machine bed. The wheelhead slide is hydraulically operated, and a rapid approach and withdrawal movement of 2 in is provided with



Keighley small crankpin grinder

Newall Group Sales Ltd.

needle valve-regulated oil cushions at each end of the stroke. A feature of the work-driving fixture, comprising a headstock and a tailstock furnished with throw blocks, is the geared transmission unit to provide a double-ended drive. Automatically, the workhead motor is started and stopped with advance or retraction of the wheelhead and a cam controller is incorporated to halt the motor so that the throw blocks are in the loading position. For gauging purposes, an alternative stop position is obtained by operation of an "inching" button.

Drive from the headstock to the tailstock is through gears, split and spring loaded to eliminate backlash, by means of a shaft running in grease-packed taper roller bearings. To facilitate disengagement, when this is necessary, an eccentric gear is fitted to the tailstock intermediate drive. The fixture also incorporates a built-in device for locating the crankpin diameter in the correct position for grinding. Consideration given to the importance of maintaining accurate wheel form for the type of work entailed has resulted in the development of a novel and highly efficient wheel-dressing and forming device. This wheelhead-mounted unit houses a diamond, which is hydraulically traversed for dressing the wheel face, and a motor-driven crusher on the same mounting for forming the radii. Engagement of diamond or crusher is obtained by means of a manually applied plunger which operates a feed screw common to both and enables a perfect blending to be made of the radii with the wheel face.

Sales of Keighley grinders are handled by Newall Group Sales Ltd., Old Fletton, Peterborough.

Armstrong cylindrical finishing machine

One of a range of honing machines produced by Armstrong (Leeds) Ltd. of Burton Street, Dewsbury Road, Leeds, 11, the model illustrated is designed for the surface finishing of cylindrical parts individually. Standard work capacity is up to 3 in diameter by 16 in long. The workpiece is set up to run freely beween centres which are mounted on the worktable. Two 14 in diameter honing wheels running in opposite directions of rotation are brought simultaneously into contact with the work by means of the lever on the front of the machine.

Armstrong cylindrical surface finishing machine
Payne Products International Ltd.

When contact is established, the work is caused to revolve on the centres and, since the work axis lies below the centre of the wheels, a cross-hatched surface of very high quality is produced. Finishes down to one micro-inch can be obtained on hardened steel parts.

The sole selling agents for Armstrong machines are Payne Products International Ltd., Lawrence Estate, Green Lane, Hounslow, Middlesex.

Turret-type drilling machine

A new addition to the range of electric drilling machines manufactured by Alfred Herbert Ltd., Coventry, is a six-position, manual indexing, turret-type model which has a maximum drill capacity of $\frac{7}{8}$ in diameter and a 5 in stroke. It can undertake work that would normally require a six-spindle machine but the floor space occupied is no more than that for a two-spindle machine. Furthermore, its production rate is higher, since no transfer of the work is necessary and all operations can be performed by one operator at a single work station

The turret, of light alloy, is mounted on a large diameter roller bearing and contains six No. 2 Morse spindles, each running in ball bearings. A single lever on the left unclamps the turret and withdraws the location plunger. After indexing, the same lever re-positions the location plunger, re-clamps the turret, and engages the drive for the spindle that has been moved to the operative position. As a safety measure, the driving clutch cannot be engaged until the plunger has correctly located the turret.

Any one of eight spindle speeds, ranging from 74 to 2,850 rev/min can be selected quickly, and three automatic down feeds are provided. As standard, these are respectively 88, 130, and 180 cuts per inch, but an alternative feed range is available. A self-selecting, adjustable stop screw controls the depth of hole for each turret station. These stops trip the automatic feed at the pre-set depth and serve as dead stops when a manual feed is used. The automatic feed can also be tripped by a hand lever. For cutting right-hand or left-hand threads, an automatic reversing attachment can be fitted to any one or to all spindles as may be required.

Turret-type drilling machine
Alfred Herbert Ltd.

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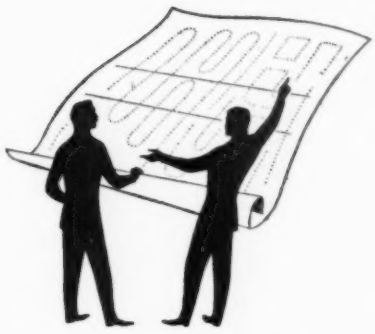

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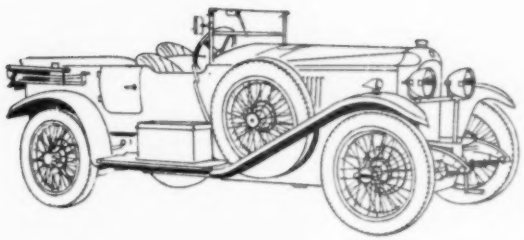

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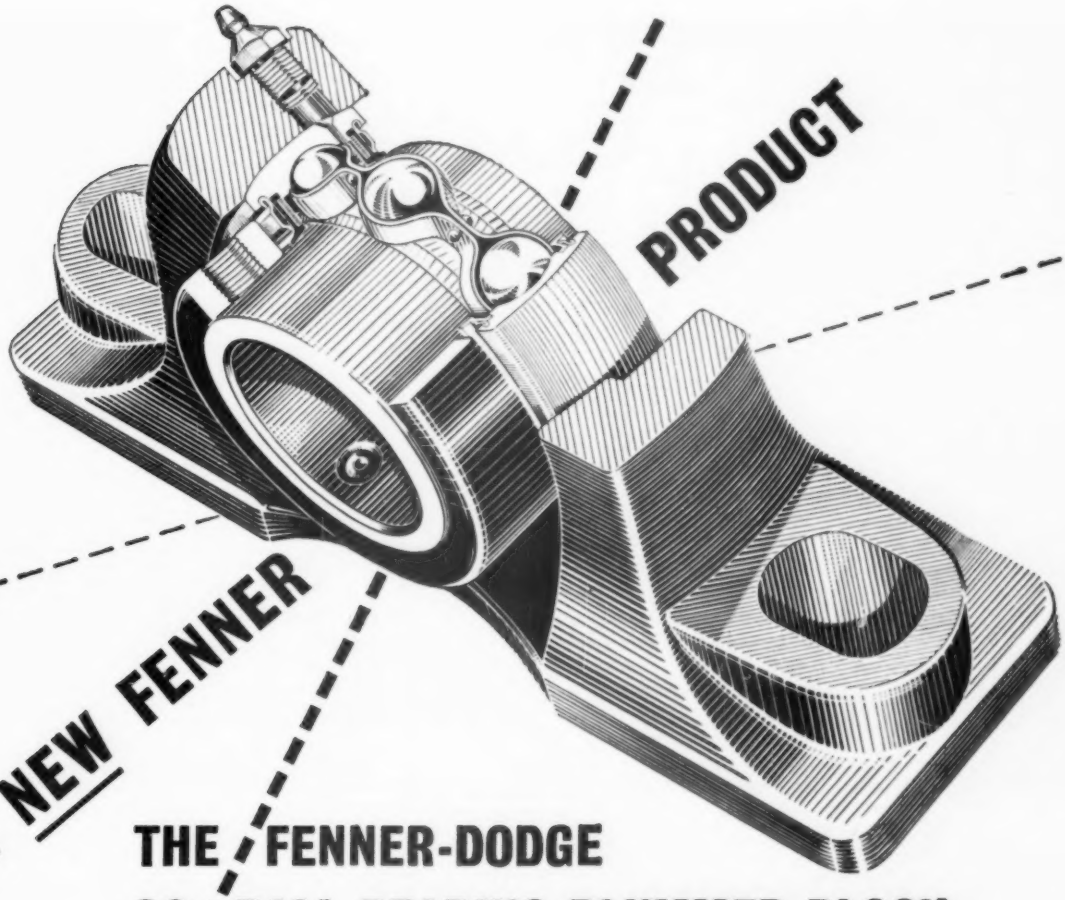

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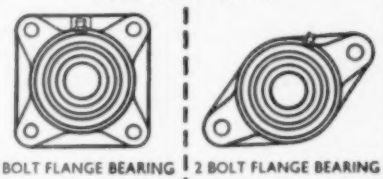

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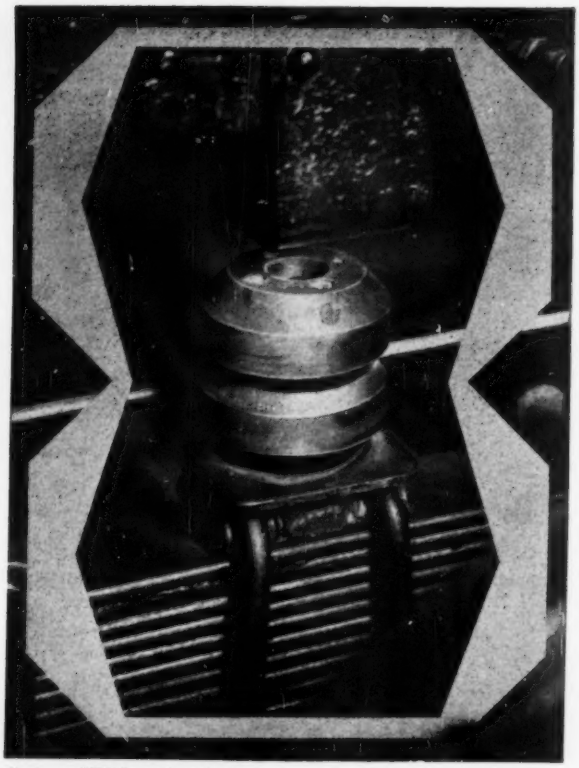

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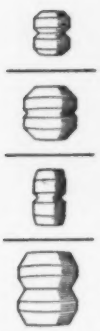

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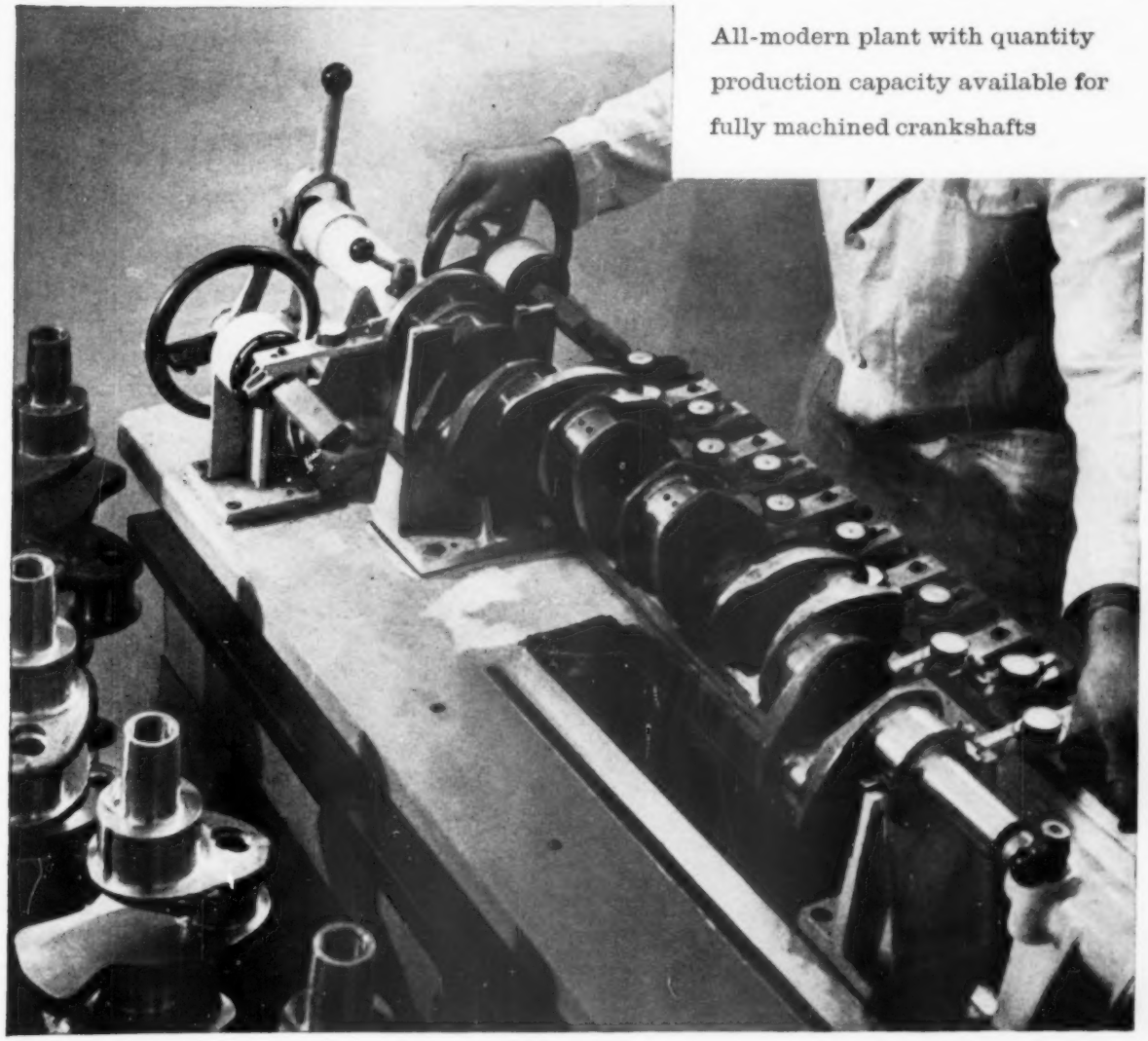

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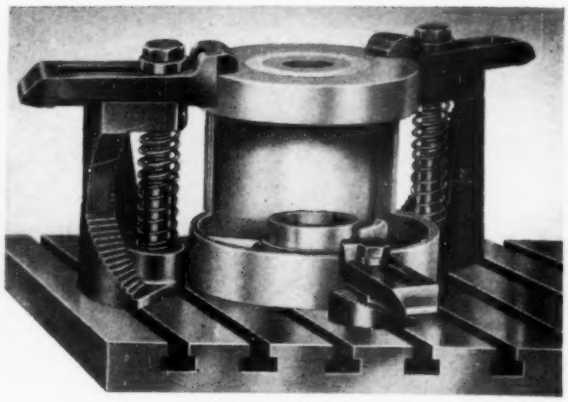

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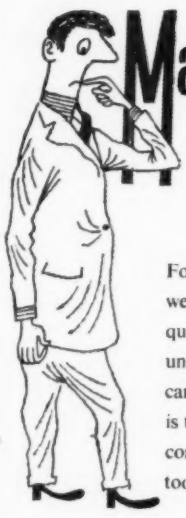

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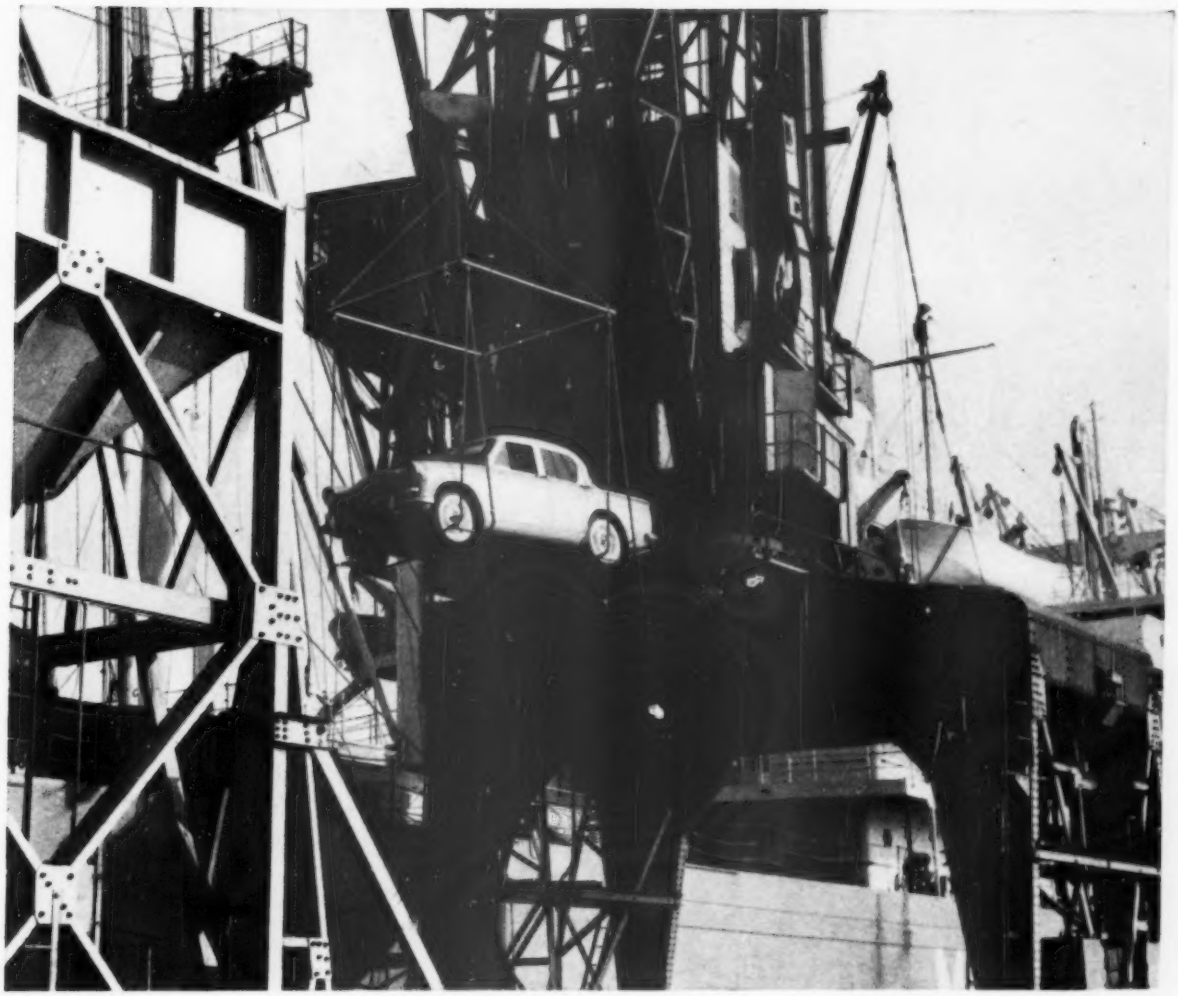

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